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EFFECT OF BENZYLOXY COMPOUNDS ON THE DEVELOPMENT AND METAMORPHOSIS OF THE RICE MOTH *CORCYRA CEPHALONICA* (STAINTON) (LEPIDOPTERA, PYRALIDAE)

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(Received 11 January 1985)

The newly discovered benzyloxy compounds A13-63604, A13-63629 and A13-63701 when applied topically at the rates of 100 µg, 50 µg, 10 µg and 1 µg, per individual to 0-24 h old last instar larvae, prepupae and pupae of the rice moth *Corcyra cephalonica* (Stainton) (Lepidoptera : Pyralidae) produced different types of developmentally intermediate forms. Larval treatment prolonged larval life span significantly, induced extra larval moults and, moths developed from such larvae were larvoid adults and adultoids. Prepupal treatment induced the production of a few adultoids. The resultant forms obtained after pupal treatments were extra-pupal instars, defective pupae (non-emerged adultoids) and adultoids. Prepupal and pupal treatments had no significant effect on the duration of pupal life. The morphological expressions after the application of such compounds showed similarity with those produced by terpenoid or sesquiterpenoid juvenile hormone analogues.

(Key words: benzyloxy compounds, development, metamorphosis, *Corcyra cephalonica*)

INTRODUCTION

The newly synthesized benzyloxy compounds are considered as potent insect juvenile hormone mimics (DE MILO *et al.*, 1980), the application of which to *Tribolium castaneum* inhibits development and metamorphosis and thereby produces developmentally intermediate forms (VIR, 1981). The novelty and advantages of non-terpenoid juvenile hormone mimics over terpenoid or sesquiterpenoid compounds have prompted workers (DE MILO & REDFERN, 1979) to investigate their effects on insects. The present investigation is, therefore, an attempt to explore the effects of three benzyloxy compounds A13-63604, A13-63629 and A13-63701 on the development and metamorphosis

of the rice moth, *Corcyra cephalonica* (Stainton) (Lepidoptera : Pyralidae), a serious pest of stored grains.

MATERIALS AND METHODS

Benzyloxy compounds A13-63604, A13-63629 and A13-63701 were applied topically in acetone solution on 0-24 h old individuals of last instar larvae, prepupae and pupae. Each individual received 1 µl solution containing the required amount of the compounds. The doses of applications were 100 µg, 50 µg, 10 µg and 1 µg per individual. Each individual, in the control treatments, received only 1 µl of pure acetone. Both treated and control individuals were reared at 29 ± 1°C, 80-90% relative humidity and 14-10 h light-dark cycle with powdered grains of sorghum [*Sorghum bicolor* (Linn.) Moench] as food. Effects caused by the compounds on the last instar larvae, prepupae and pupae were evaluated from the number of ecdyses, the time of

attainment of subsequent developmental stages and the type of resultant forms obtained from the treated and control individuals. The nature of significance in the difference of mean values of the duration of emerged moths in treated and control series was tested by analysis of variance technique.

RESULTS

Effects on the development and metamorphosis

The different categories of resultant forms, developed after the application of three benzyloxy compounds to the larvae, prepupae and pupae of *C. cephalonica*, were: larvoid adults or larval-imaginal intermediates (L-I, Figs. 1, 2) (antennae, labrum, maxillae and labial palps incompletely differentiated into imaginal organs preserving many larval features), adultoids (A, Figs. 3, 4, 5) (wings twisted or curly, short, pigmentation less; mouth parts attained imaginal status but were defective), extra pupal instars (EP) (pupae underwent additional moult, none of the exuviae could be shed and, eventually died), defective pupae or non-emerged adultoids (DP, Fig. 6) (externally normal pupae but inside, adultoids) and normal adults.

Effects of larval treatments: The three benzyloxy compounds A13-63604, A13-63629 and A13-63701 when applied to the larvae prolonged the larval life span 1-2, 1-3 and 5-8 times respectively. Of course, active feeding lasted for about half of the total life period. Moreover, the experimental larvae underwent 0-1, 1-3 and 2-4 extra moults after A13-63604, A13-63629 and A13-63701 application respectively (ROYCHOUDHURY & CHAKRAVORTY, 1983, 1984). The giant supernumerary larvae, thus formed, ultimately underwent pupation and different resultant forms

developed (Tables 1-3). In the experimental series, there occurred a significant percentage of larval death which was always higher at higher dosage. There was no effect in 1 μ g treatments of both A13-63604 and A13-63701 and, moths were externally normal.

Effects of prepupal treatments: Prepupae when treated with A13-63604, A13-63629 and A13-63701 underwent pupation and died very shortly as externally normal pupa. There was 100% mortality in case of A13-63604 and A13-63701 treatments and, 1 μ g did not show any effect (Tables 1, 3). In both 10 μ g and 1 μ g treatments of A13-63629 a few adultoids were produced (Table 2).

Effects of pupal treatments: Benzyloxy compounds A13-63604, A13-63629 and A13-63701 when applied to the pupae showed high rate of mortality which was always more in higher doses. The resultant forms developed after pupal treatments, were: adultoids, defective pupae and extra pupal instars (Tables 1-3). In A13-63604 and A13-63701 treatments, however, 1 μ g did not show any effect and the moths were normal in appearance.

Effect on duration (days between treatment and emergence)

Larval treatments prolonged the larval life and thereby increased the duration which differed significantly from control data ($F=216.255$, $P<0.001$; d.f. 4,45 for A13-63604 treatment; $F=467.944$, $P<0.001$; d.f. 4,45 for A13-63629 treatment and $F=1753.789$, $P<0.001$; d.f. 4,45 for A13-63701 treatment). The dosage effects were also significantly different ($P<0.001$). Treatments of 1 μ g of A13-63603 and A13-63701 had no significant effect ($P>0.05$) (Table 4).

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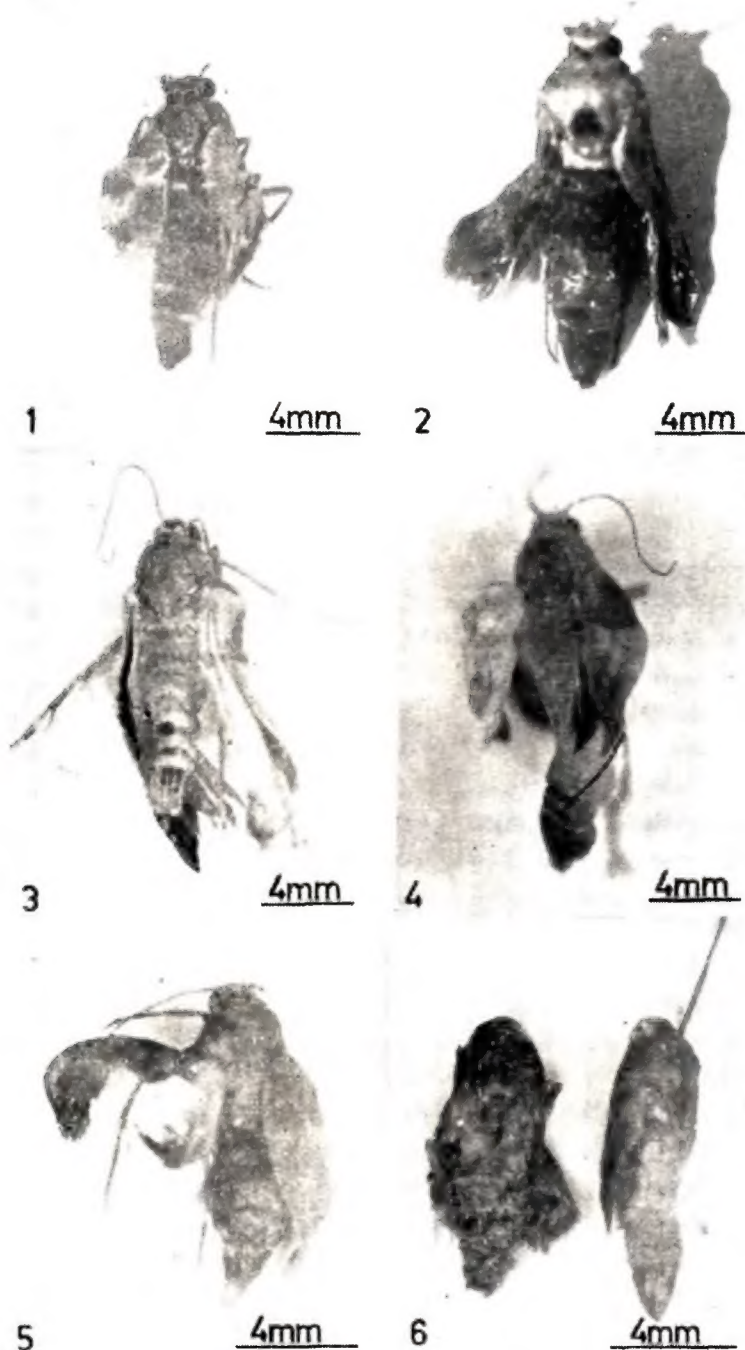
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Figs. 1—6. Different types of intermediate forms of *C. cephalonica* developed after application of benzyloxy compounds. 1-Larvoid adult or larval imaginal intermediate due to 100 μ g of A13-63604 on last instar larva; 2-Larvoid adult or larval-imaginal intermediate due to 100 μ g of A13-63629 on last instar larva; 3-Adultoid due to 50 μ g of A13-63604 on last instar larva; 4 Adultoid due to 100 μ g of A13-63701 on last instar larva; 5 Adultoid due to 10 μ g of A13-63629 on pupa; 6-Defective pupae (non-emerged adultoids) due to 10 μ g of A13-63701 on pupae.

TABLE 1. Rate of occurrence of resultant forms and pre-emergence mortality after application of the benzyloxy compound A13-63604 on last instar larvae, prepupae and pupae of *C. cephalonica*.

Stage treated	Dose (μ g/ind)	Total no. treated	No. of extra moult	Resultant forms (%)		Mortality (%)
Last instar larvae	100	76	1	L-I	26.31	40.80*
				A	21.05	
				NA	11.84	
	50	70	Nil	L-I	11.42	24.30*
				A	17.14	
				NA	47.14	
	10	70	Nil	L-I	2.85	22.87*
				A	7.14	
				NA	67.14	
	1	50	Nil	NA	82.00	18.00*
Prepupae	Control	30	Nil	NA	83.33	16.67*
	100	30	Nil	NE	Nil	100.00**
	50	30	Nil	NE	Nil	100.00**
	10	30	Nil	NE	Nil	100.00**
	1	30	Nil	NA	63.33	36.67*
	Control	30	Nil	NA	70.00	30.00*
Pupae	100	38	Nil	A	44.73	31.59*
				DP	23.68	
	50	35	Nil	A	51.50	31.40*
				DP	17.10	
	10	52	Nil	A	53.84	26.93*
				DP	19.23	
	1	20	Nil	NA	70.00	30.00*
	Control	30	Nil	NA	80.00	20.00

NE = No emergence. * Individuals died after undergoing very little or no morphogenetic change. ** Died just after pupation.

Prepupal treatments did not show any effect on the duration which differed non-significantly ($F=0.13$, $P>0.05$; d.f. 1,18 for A13-63604 treatment and $F=0.039$, $P>0.05$; d.f. 1,18 for A13-63701 treatment) (Table 4).

Pupal treatments had also no significant effect on the duration which were non-significantly different ($F=2.088$, $P>0.05$; d.f. 4,45 for A13-63604 treatment; $F=0.925$, $P>0.05$; d.f. 4,45 for A13-63629 treatment and $F=0.163$,

$P>0.05$; d.f. 4,45 for A13-63701 treatment) (Table 4).

DISCUSSION

The present findings demonstrate that the three benzyloxy compounds have the potency to interrupt development and metamorphosis of *C. cephalonica* and thereby produce striking disorders in the external morphology. This is possible because these compounds are juvenile hormone mimics and it is known that the metamorphosis and morphogenesis

TABLE 2. Rate of occurrence of resultant forms and pre-emergence mortality after application of the benzyloxy compound A13-63629 on last instar larvae, prepupae and pupae of *C. cephalonica*

Stage treated	Dose (μ g ind)	Total no. treated	No. of extra moult	Resultant forms (%)		Mortality (%)
Last instar larvae	100	70	2—3	L—I	22.85	48.58*
				A	28.57	
	50	60	1—2	L—I	21.66	41.68*
				A	36.66	
	10	60	1—2	L—I	25.00	48.34*
				A	26.66	
	1	60	0—1	L—I	13.33	31.67*
				A	15.00	
				NA	40.00	
	Control	30	Nil	NA	83.33	16.67*
Prepupae	100	30	Nil	NE	Nil	100.00**
	50	30	Nil	NE	Nil	100.00**
	10	30	Nil	A	3.33	96.67**
	1	30	Nil	A	3.33	96.67**
	Control	30	Nil	NA	70.00	30.00*
Pupae	100	40	Nil	A	37.50	62.50*
	50	35	Nil	A	34.28	65.72*
	10	30	Nil	A	33.33	66.67*
	1	26	Nil	A	30.76	30.78*
	Control	30	Nil	NA	38.46	20.00*

NE = emergence. * Individuals died after undergoing very little or no morphogenetic change. ** Died just after pupation.

are related with the hormones and their titre in the body (NOVAK, 1975).

In the present work, induction of prolonged larval life accompanied by the production of extra larval instars and growth through extended period after the topical treatments of three benzyloxy compounds is similar to the effects produced by juvenoids or juvenomimetic compounds on *C. cephalonica* (RAMAKRISHNAN & JOSHI, 1977; SRIVASTAVA, 1981; DEB & CHAKRAVORTY, 1985). These benzyloxy compounds are considered as potent insect juvenile hormone mimics (DE MILO *et al.*, 1980). Thus

the different phenotypic abnormalities in the resultant forms may be due to differential inhibition of larval-imaginal transformation of external organs (SUNDARAMURTHY, 1978) which again occurs due to a change in RNA synthesis or in cell division in the imaginal disc of larvae (PATEL & MADHAVAN, 1969; OBERLANDER, 1972). The production of larvoid adults or adultoids from the externally normal giant pupae which developed after larval treatment, may be due to the delayed action of benzyloxy compounds similar to the persistent covert effect of the juvenoids (NIJHOUT, 1975; ONDRACEK *et al.*, 1981).

TABLE 3. Rate of occurrence of resultant forms and pre-emergence mortality after application of the benzyloxy compound A13-63701 on last instar larvae, prepupae and pupae of *C. cephalonica*.

Stage treated	Dose (μ g/ind)	Total no. treated	No. of extra moult	Resultant forms (%)		Mortality (%)
Last instar larvae	100	90	3-4	L-I	44.44	41.12*
				A	14.44	
	50	75	2-3	L-I	37.33	33.34*
				A	29.33	
	10	75	2-3	L-I	24.00	29.34*
				A	46.66	
Prepupae	1	50	Nil	NA	80.00	20.00*
	Control	30	Nil	NA	83.33	16.67*
	100	30	Nil	NE	Nil	100.00**
	50	30	Nil	NE	Nil	100.00**
	10	30	Nil	NE	Nil	100.00**
	1	30	Nil	NA	60.00	40.07*
Pupae	100	40	0-1	NA	70.00	30.00*
				A	30.00	
				DP	12.50	
	50	36	0-1	EP	10.00	44.50*
				A	36.10	
				DP	16.65	
Pupae	10	32	0-1	EP	2.75	40.64*
				A	46.87	
				DP	9.37	
	1	30	Nil	EP	3.12	23.34*
				NA	76.66	
				NA	80.00	

NE = No emergence. * Individuals died after undergoing very little or no morphogenetic change. ** Died just after pupation.

Morphological expression in the resultant forms obtained after prepupal and pupal treatments shows a general similarity with those recorded after juvenoid treatments. Differences in sensitivity may be due to species specificity (SEHNAL, 1983).

The high percentage of pre-emergence mortality in all the treatments may be due to disturbed ecological niches, damage in the internal organs (SEHNAL & SKUHRAVY, 1976) or due to lethal

effects of benzyloxy compounds (ROBERTSON & KIMBALL, 1979; KIM *et al.*, 1981).

It is, thus evident that the functional principle of the three benzyloxy compounds has similarity with the terpenoid or sesquiterpenoid juvenile hormone analogues. The effective suppression of population build-up by reducing adult emergence indicates a promising role of such compounds in pest control programmes.

Acknowledgements: Grateful thanks are due to Dr. A. B. BORKOVEC, Agricultural Environmental

TABLE 4. Data on duration (days) of emergence of moths after larval (LT), prepupal (PPT) and pupal treatments (PT) with three benzyloxy compounds in *C. cephalonica*. Range values are inside parentheses.

Dose ($\mu\text{g}/\text{ind}$)	Duration Mean \pm S E								
	A13-63604			A13-63629			A13-63701		
	LT	PPT	PT	LT	PPT	PT	LT	PPT	PT
100	52.80 \pm 5.41 (44-60)	NE	8.30 \pm 1.00 (7-10)	67.90 \pm 3.30 (64-75)	NE	7.60 \pm 1.01 (6-9)	143.20 \pm 6.70 (132-150)	NE	7.70 \pm 1.26 (6-10)
50	44.60 \pm 3.41 (40-51)	NE	8.00 \pm 0.77 (7-9)	46.20 \pm 2.48 (43-51)	NE	7.80 \pm 0.74 (7-9)	107.70 \pm 4.62 (100-113)	NE	7.40 \pm 1.28 (6-10)
10	39.10 \pm 2.84 (35-43)	NE	7.50 \pm 1.02 (6-9)	40.10 \pm 2.64 (35-45)	SE	7.00 \pm 0.77 (6-8)	91.70 \pm 3.19 (87-97)	NE	7.50 \pm 0.92 (6-10)
1	18.30 \pm 1.26 (17-20)	11.10 \pm 1.04 (10-13)	7.20 \pm 0.97 (6-9)	34.20 \pm 2.52 (30-39)	SE	7.40 \pm 1.11 (6-9)	18.30 \pm 1.41 (17-22)	11.00 \pm 0.89 (10-13)	7.30 \pm 1.18 (6-9)
Control	17.60 \pm 1.28 (16-20)	10.90 \pm 1.22 (9-13)	7.40 \pm 0.91 (6-9)	17.60 \pm 1.28 (16-20)	10.90 \pm 1.22 (9-13)	7.40 \pm 0.91 (6-9)	17.60 \pm 1.28 (16-20)	10.90 \pm 1.22 (9-13)	7.40 \pm 0.91 (6-9)
CD at 1%	4.103	NS	NS	3.224	Na	NS	5.082	NS	NS
5%	3.072	NS	NS	2.413	Na	NS	3.804	NS	NS

NE = No emergence, SE = Single emergence, Na = Not arise, CD = Critical difference, NS = Non-significant.

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CONTROL OF TERMITES IN WHEAT CROP WITH INSECTICIDES APPLIED THROUGH IRRIGATION

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Emulsifiable concentrates of aldrin, chlordane, chlorpyrifos, heptachlor and lindane insecticides, each at the rate of 150, 300, 400, 600, 800 & 1000 g ai per hectare were applied to wheat crop through first irrigation against termites during 1978—1979 and 1980—1981 seasons. All the insecticides tested at various dosages checked the infestation and gave higher yields than control. Aldrin @ 300 and 400 g ai heptachlor and lindane @ 400 g ai and chlordane @ 600 g ai per hectare were quite effective to impede the infestation. The grain yield under these treatments did not indicate any significant difference but on the numerical scale aldrin @ 400 g ai per hectare offered the highest net income followed by heptachlor at the same dosage.

(Key words: aldrin, chlordane, chlorpyrifos, heptachlor, lindane, termites, wheat)

INTRODUCTION

In Rajasthan two species of termites namely *Odontotermes obesus* (Rambur) and *Microtermes obesi* Holmgren are widely distributed which are mainly responsible for ravages to wheat crop. Besides rain-fed wheat crop, tubewell and open well irrigated crop grown in lighter soils are also vulnerable to termite attack due to less frequency of irrigations.

Now and then prophylactic chemical control measures are not followed by the cultivators and under such situations it becomes necessary to treat the growing crop. Formerly the application of aldrin 30 EC or lindane 20 EC @ 4 to 5 litres per hectare with irrigation water recommended for termite control (Anonymous 1975, 1976, 1978—1979). These application rates were not only high and expensive

but were responsible for environmental contamination. Studies by SANDHU & SOHI (1978) revealed that adequately good protection to standing crop from termites can be achieved with lower dosages of aldrin through irrigation. It was, therefore, considered appropriate to work out the lowest possible effective dosages of some promising insecticides to reduce both the cost of control operation and the environmental pollution.

MATERIALS AND METHODS

Two post-sowing insecticidal trials were conducted, one during 1978—1979 season with twenty one treatments (Table 1) and the other during 1980—1981 season with thirteen treatments (Table 2). The trials were laid out in a randomised block design with three replications. The net plot measured 4.5 × 3.5m having fourteen rows of 4.5m length each. Recommended dosages of fertilisers were applied and the seed was used at the rate of 100 kg per hectare.

Insecticides were applied through first irrigation after about twenty one days of sowing. The measured quantity of insecticide per plot

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was first diluted in a bucket full of water. Later on this emulsifiable liquid was slowly released at the water inlet into the plot when irrigation water had covered the plot surface and continued till it flooded the entire area.

Observations on plant and ear-head damage were recorded by surveillance of the whole plot. The damaged plants observed just before the treatment were pulled out and further damage was recorded two weeks after the treatment. The ear-head damage was observed twice during February–March and represent the composite number. Observations on damage were transformed into square root values for statistical analysis. These values are shown in parenthesis against their corresponding figures in Table 1 and 2.

RESULTS

Trial 1978–1979 season: All the treatments were significantly superior than the control which is evident from the data recorded on the number of damaged plants and ear-heads as well as grain yield (Table 1). Two weeks after treatment, the plots treated with chlorpyrifos at 400, 600 and 800 g ai, and chlordane at 400 g ai per hectare were at par (8757 to 9557 damaged plants per hectare) and proved inferior to the remaining insecticidal treatments (2211 to 4581 damaged plants). There was no significant difference between 1000 g ai and 400 g ai, per hectare dosages of aldrin, heptachlor and lindane. The minimum dosages of different insecticides with promising results were: 400 g ai of aldrin, lindane and heptachlor, 600 g ai of chlordane and 1000 g ai of chlorpyrifos. Increases in the dosages of these insecticides though demonstrated a decrease in the infestation, the differences were not significant. Similar trend was observed when the mean grain yields were compared. The ear-head damage gave almost parallel results except that aldrin at 1000 g ai provided significantly better control than 400 g ai of the same insecticide or 600 g

ai of lindane or heptachlor or 800 g ai of chlordane or 1000 g ai of chlorpyrifos.

Trial 1980–1981 season: The data on the effect of lower dosages of aldrin, chlordane, heptachlor and lindane on termite infestation and yield are presented in Table 2. The observations on plant and ear-head damage and grain yield demonstrated that even the lowest dosages of all the insecticides were significantly better than control. Observations on plant damage recorded two weeks after treatment, indicated very good control of termites with 400 and 300 g ai of aldrin, 400 g ai of heptachlor and 600 g ai of chlordane. However, lindane was not significantly superior at 400 g ai dosage. The ear-head damage revealed that 400 and 300 g ai of aldrin, 400 g ai of heptachlor and lindane, and 600 g ai of chlordane treatments were distinctly effective in preventing the crop from termite attack and also in increasing the grain yield. There was no significant difference between 300 g ai of heptachlor and lindane, 400 g ai of chlordane and 150 g ai of aldrin. But this group of treatments provided less protection to the crop as compared to the first group of treatments.

The overall data indicated that aldrin at 400 and 300 g ai, heptachlor and lindane at 400 g ai and chlordane at 600 g ai per hectare were quite effective in retarding termite damage coupled with the eventual increase in grain yield.

DISCUSSION

During present studies the results of the initial trial (Table 1) on wheat crop indicated that 400 g ai of aldrin, lindane and heptachlor or 600 g ai of chlordane per hectare applied with first irrigation

TABLE 1. Effect of application of insecticidal emulsions through irrigation on termite damage and yield of wheat (1978—1979).

Sl. No.	Treatments	Dosage (g ai per ha)	Mean number of damaged plants per hectare 2 weeks after treatment		Mean number of damaged earheads per ha		Mean grain yield (qt./ha)
1.	Aldrin	1000	2211	(47.02)	2737	(52.32)	29.34
2.	Aldrin	800	3175	(56.35)	7262	(85.22)	28.64
3.	Aldrin	600	3958	(62.91)	12071	(109.87)	28.24
4.	Aldrin	400	4438	(66.62)	15366	(123.96)	28.07
5.	Chlordane	1000	3387	(58.20)	10660	(130.25)	28.39
6.	Chlordane	800	4206	(64.85)	16126	(126.99)	27.77
7.	Chlordane	600	4339	(65.87)	18349	(135.46)	24.16
8.	Chlordane	400	8757	(93.58)	83313	(288.64)	22.92
9.	Chlorpyrifos	1000	4581	(67.68)	18233	(135.03)	26.94
10.	Chlorpyrifos	800	8584	(92.65)	97294	(311.92)	22.57
11.	Chlorpyrifos	600	8990	(94.82)	112326	(335.15)	22.26
12.	Chlorpyrifos	400	9557	(97.76)	130552	(361.32)	22.15
13.	Heptachlor	1000	2554	(50.54)	4259	(65.26)	28.82
14.	Heptachlor	800	3405	(58.35)	7117	(84.36)	28.43
15.	Heptachlor	600	4206	(64.85)	16221	(127.36)	27.95
16.	Heptachlor	400	4384	(66.21)	17461	(132.14)	27.37
17.	Lindane	1000	3024	(54.99)	5636	(75.07)	28.79
18.	Lindane	800	4397	(66.31)	12681	(112.61)	28.11
19.	Lindane	600	4206	(64.85)	16126	(126.99)	27.81
20.	Lindane	400	4070	(63.80)	16644	(129.01)	27.58
21.	Control	—	83666	(289.25)	386610	(621.78)	18.37
S Em \pm			7.66		25.06		0.88
CD at 5%			21.88		71.61		2.51

TABLE 2. Effect of application of insecticidal emulsions through irrigation on termite damage and yield of wheat (1980-1981).

Sl. No.	Treatments	Dosage (g ai per ha)	Mean number of damaged plants per hectare 2 weeks after treatment		Mean number of damaged ear-heads per hectare		Mean grain yield (qt ha)
1.	Aldrin	400	4120	(64.19)	13635	(166.77)	29.23
2.	Aldrin	300	5595	(74.80)	19505	(139.66)	28.50
3.	Aldrin	150	30318	(174.12)	61034	(247.05)	25.31
4.	Chlordane	600	5768	(75.95)	18545	(136.18)	28.95
5.	Chlordane	400	27549	(165.98)	57379	(239.54)	26.15
6.	Chlordane	300	45084	(212.33)	90914	(301.52)	22.77
7.	Heptachlor	400	6551	(80.94)	17119	(130.84)	28.93
8.	Heptachlor	300	24863	(157.68)	45963	(214.39)	26.02
9.	Heptachlor	150	46238	(215.03)	107409	(327.73)	22.55
10.	Lindane	400	7429	(86.19)	17644	(132.83)	28.05
11.	Lindane	300	23004	(151.67)	55408	(235.39)	26.12
12.	Lindane	150	51765	(227.52)	113481	(336.87)	21.73
13.	Control	—	86798	(294.92)	325343	(570.30)	19.25
S Em \pm			7.42		14.05		0.49
CD at 5%			21.65		41.01		1.44

TABLE 3. Economics of insecticidal treatments applied through irrigation for the control of termites in wheat crop.

Sl. No.	Treatments	Dosage (g ai per ha)	Yield of* wheat (q ha)	Total Income (Rs. ha)**	Cost of treatments (Rs. ha)	New income over control (Rs. ha)
1.	Aldrin	400	29.23	5261.40	108.69	1687.71
2.	Aldrin	300	28.50	5130.00	88.50	1576.50
3.	Chlordane	600	28.95	5211.00	170.00	1576.00
4.	Heptachlor	400	28.93	5207.00	127.00	1615.00
5.	Lindane	400	28.05	5049.00	120.00	1464.00
6.	Control	—	19.25	3465.00	—	—

* Based on data given in Table 2

** Calculated at the rate of Rs. 180.00 per quintal

were as good as the higher dosages of these insecticides. Further assessment of lower dosages of these insecticides confirmed the efficacy of aldrin, lindane, heptachlor and chlordane. Application of aldrin even at 300 g ai per hectare was at par with 400 g ai per hectare of the same insecticide (Table 2).

Differential effectiveness of lower dosages of aldrin has been reported from Haryana (VERMA *et al.*, 1974) and Punjab (SANDHU & SOHI, 1978). In Punjab even the lowest tried dosage of 6.625 litres of aldrin 30 EC (equivalent to ca 187.5 g ai) per hectare was found as effective as 5 litres of aldrin 30 EC (equivalent to ca 1500 g ai) per hectare. While in Haryana aldrin at the dosage of 625 g ai (equivalent to ca 2 litres of 30 EC) per hectare was slightly inferior to 1250 g ai (equivalent to ca 4 litres of 30 EC) dosage per hectare on the basis of grain yield but did not differ significantly in infestation level. Thus the present results support the investigations of other workers regarding the efficacy of lower dosages of aldrin and further suggest the use of heptachlor, lindane and chlordane at much lower rates than the previously recommended dosages. Moreover, a comparison of the data of economics (Table 3) of the treatments construed that aldrin @ 400 g ai is most profitable followed

by heptachlor @ 400 g ai, aldrin @ 300 g ai, chlordane @ 600 g ai and lindane @ 400 g ai per hectare.

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THREE NEW SAWFLIES OF THE GENUS *TENTHREDO* LINN. (TENTHREDINIDAE : HYMENOPTERA) FROM INDIA

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Three new species belonging to *Tenthredo* Linn. (Tenthredininae : Tenthredinidae : Hymenoptera) viz., *T. darjeelingensis*, *T. facepunctata* and *T. antennata* have been described and illustrated from Himalayan regions (India).

(Key words: new sawflies, *Tenthredo*)

Genus *Tenthredo* belongs to the subfamily Tenthredininae (Symphyta: Hymenoptera). This genus is characterized by the straight cross-vein in the anal cell of forewing; closed Rs and M cells in the hindwing and by the propodeum divided by means of mid-longitudinal furrow. The broadly constricted anal cell of forewing and longer hindcoxa are represented in genera *Pachyprotasis* Hartig and *Macrophya* Dahlbom but not represented in genus *Tenthredo* Linn. As such these are the characters which differentiate the genus *Tenthredo* from these two closely related genera.

No reference is available on the biology and the host plants of Indian species falling under this genus. However, Benson (1952) has given details about the host plants being attacked by British sawflies which include *Brassica*, *Mentha*, *Ranunculus*, *Solanum tuberosum*, *Rosa*, *Salix*, *Sorbus* and many other plants of family Graminae.

From the literature it is evident that under the genus *Tenthredo* falls the largest number of about 700 species (Smith, 1979). Malaise (1945) has prepared a comprehensive key to the species

belonging to South-East Asia. Within Indian territory so far 79 species have been recorded which belong to this genus.

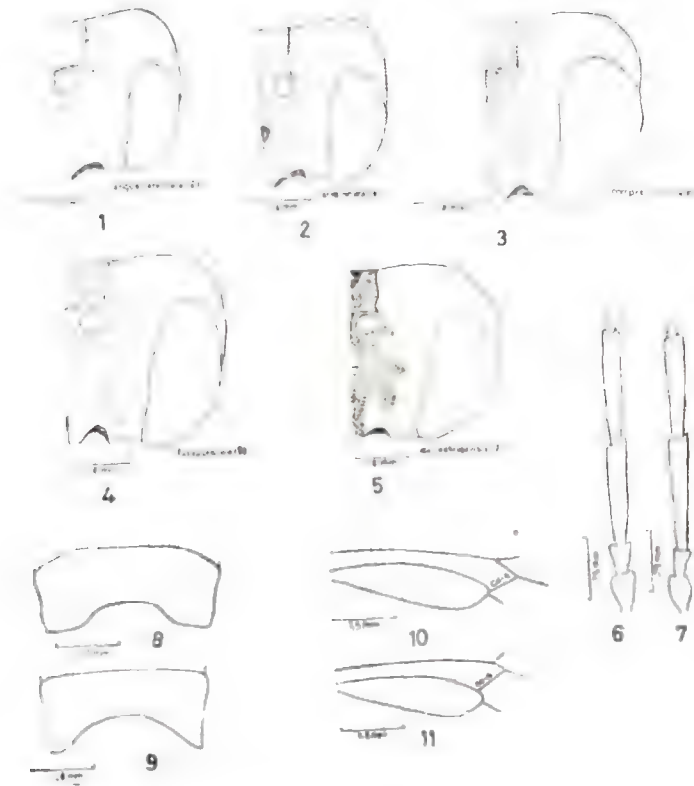
In the present communication, three new species of *Tenthredo* Linn. have been included which were collected from different Himalayan regions. Since these species are only confined to the Himalayan forests, it is worthwhile to know details about their habitats which may help in the management of forest wealth.

Terminology used for the morphological descriptions is after Ross (1937, 1945) and Malaise (1945). The holotypes/paratypes will be deposited in the Indian Museum, Calcutta, as well as in the museum of the Zoology Department, Punjabi University, Patiala.

1. *Tenthredo darjeelingensis* sp. nov.

Figs. 5, 16, 17

Female: Length, 13.6 mm. Antenna black with pale yellow on lower side of segments 1–5. Head pale yellow with the following black (Fig. 5): tip of mandible, median fovea, frons, ocellar and postocellar areas, and longitudinal stripe on posterior side of head. Thorax



Figs. 1—5. Left half of heads, dorsal view:— 1. *T. angustiannulata* Malaise; 2. *T. antennata* sp. nov.; 3. *T. compressicornis* Cameron; 4. *T. facepunctata* sp. nov.; 5. *T. darjeelingensis* sp. nov.; 6. Basal half of antenna of *T. angustiannulata* Malaise; 7. Basal half of antenna of *T. antennata* sp. nov.; 8. Clypeus of *T. compressicornis* Cameron; 9. Clypeus of *T. facepunctata* sp. nov.; 10. Anal cell of hindwing of *T. compressicornis* Cam. showing reception of cu-a; 11. Anal cell of hindwing of *T. facepunctata* sp. nov. showing reception of cu-a.

brownish yellow with the following black propleuron, upper pronotal angle, spot on praescutum, spots on mesonotal lateral lobes, anterior margin of metanotum barring the space between cenchri, upper corner of mesepisternum, margins of mesepimeron, and mesosternum. Legs pale yellow except black hindcoxa. Abdomen dirty white with apical segments and sawsheath black. Wings hyaline with apices infuscated.

Antenna laterally compressed. Labrum flat; clypeus convex with semicircular emargination; supra-antennal tubercle sloping backwardly; circum-, inter- and postocellar furrows present; prominent ridges surround the circumocellar furrows; and postocellar area longer than wide, narrow anteriorly, broad posteriorly. Thorax with mesoscutellum roundly elevated and apical tooth of tarsal claw longer than subapical. Sheath elongated

straight above and below and rounded at apex.

Head impunctate; mesonotum and mesosternum very minutely and finely punctured, and mesepisternum opaque. Lancet not examined.

Male: Length, 12.5 mm; antenna black with inner side of joints 1-4 pale yellow. Coloration similar to female except the absence of black color on posterior side of head, mesepisternum and mesosternum; and abdomen brownish yellow with black terminal segments. Structure and sculpture as for female. Harpe and parapenis as in Fig 16; penis valve (Fig. 17) with roughly spherical valviceps,

Holotype: Male, WEST BENGAL; DARJEE-LING, Ghum 2280 m, 30.iv.80.

Paratypes: 1♀, 1♂, same data as for holotype.

Discussion: This species runs through couplet numbers 1, 12, 17, 18, 23, 25 and 28 in Malaise's key (1945). Judging from literature, *T. darjeelingensis* sp. nov. is somewhat related to *T. purpurepennis* Malaise. But it differs by the absence of distinct carina on mesoscutellum, the color of antenna, head and thorax and the nature of the sawsheath. From another closely related species *T. limiticola* Malaise, it may be separated by depressed frons, punctuation of mesepisternum, and by the coloration of antenna and metasternum. From *T. heinrichi* Malaise, it can be differentiated by the punctuation of the mesepisternum form of tarsal claw, and by the ratio of 3rd to 4th antennal joints.

The species name has been taken from type locality.

2. *Tenthredo facepunctata* sp. nov. Figs. 4, 9, 11, 14, 15

Female: Average length, 10.0 mm. Antenna black with joints 4 (except black stripe on the apical half underneath) and 5 pale yellow. Head pale yellow with tip of mandible, supraclypeal furrow widely, and elongated spot medially from base of antenna to posterior side black. Thorax black with following pale yellow: pronotal angles broadly, tegula, arrow head spot at apex of praescutum laterally, mesoscutellum and its appendage, cenchrus, metaseutellum, broad spot on mesepisternum medially, broad stripe on mesepimeron, spots on mesosternum and metepisternum, posterior margin of metepimeron and metasternum. Legs pale yellow with tibiae and tarsi moderately brownish yellow; basal 3/4 of coxae fore femur and tibia, and mid femur black posteriorly. Abdomen fusco-piceous with brownish yellow propodeum, rarely brownish spots on 2nd and 3rd terga. Wings hyaline, lightly infuscated uniformly with yellowish tint; stigma fulvous and venation black.

Antenna longer than abdomen with compressed apical joints. Clypeus with pointed lateral teeth (Fig. 9); supra-antennal tubercle confluent with frontal ridge; median fovea with faint longitudinal ridge; ocellar and postocellar areas elevated having prominent inter and postocellar furrows. Mesoscutellum flat. Reception of cu-a to the anal cell of the hindwing as in Fig. 11. Sheath (Fig. 15) rounded dorsally.

Frons, ocellar and postocellar areas with scattered punctures (Fig. 4); mesonotum minutely and densely, lower side of mesepisternum and mesosternum



Figs. 12. Lancet of *T. angustiannulata* Malaise
13. Lancet of *T. antennata* sp. nov.; 14.
Lancet of *T. facepunctata* sp. nov.; 15. Saw-
sheath of *T. facepunctata* sp. nov.; 16. Harpe
and parapensis of *T. darjeelingensis* sp. nov.
17. Penis valve of *T. darjeelingensis* sp. nov.

closely punctured; and mesoscutellum without setae.

Lancet (Fig. 14) with about 21 serrulae, each almost flat, low, without anterior and 6–7 posterior subbasal teeth; however, basal two serrulae without, and 3rd with 2 posterior subbasal teeth; and segments separated by vertical rows of fine setae.

Male: Unknown.

Holotype: Female, UTTAR PRADESH: Nainital, Ranikhet. Chaubatia 2300 m, 3.x.80.

Paratypes: 2♀♀, same data as for holotype.

Discussion: In Malaise's key (1945), *T. facepunctata* sp. nov. runs upto couplet 44. Beyond this, it is closely allied to *T. compressicornis* Cameron but differs from it by the possession of pointed lateral teeth of clypeus, punctures on head, presence of ridge in median fovea, absence of setae on mesoscutellum, and infuscation on forewing in comparison to truncated lateral teeth of clypeus (Fig. 8), smooth head (Fig. 3), absence of ridge in median fovea, presence of setae on mesoscutellum, and lightly infuscated apex of forewing of *T. compressicornis* Cam. From *T. indica* Cam. and *T. concinna* Moc., it can be separated by pale yellow hind femur (black in *indica* and *concinna*) and pattern of coloration on abdominal terga. One paratype has extreme hind margin of deflexed terga, and sterna pale yellow.

The species name has been taken from the specific punctures of the head.

3. *Tenthredo antennata* sp. nov.

Figs. 2, 7, 13

Female: Length, 10.5 mm. Antenna black with apical half of 4th joint faintly white, basal joints 1 to 3 and basal half of fourth brown. Head with labrum, clypeus, base of mandible, longitudinal stripe on inner and spot on lower hind orbits pale yellow; broad longitudinal black spot between antenna and crassa running through postocellar area and joined with posterior side of the head by two black stripes; and upper hind orbit and temple brownish. Thorax black with the following pale yellow; upper margin and angles of pronotum, rounded spot on mesonotum, mesoscutellum and its appendage, broad spot on mesepisternum, mesepimeron, posterior 3/4 of mesosternum, and spots on metasternum. Legs

pale to brownish yellow with black on apex of coxae, basal $\frac{3}{4}$ of fore femur and tibia posteriorly, $\frac{3}{4}$ of mid and hind femora, and tibiae entirely. Abdomen black with propodeum, lateral sides of tergum 2, posterior sides of terga 3 and 4, and middle of last tergum pale yellow. Wings subhyaline with stigma and costa fulvous, remaining veins black.

Antenna with 3rd joint longer than 4th (6:5) (Fig. 7). Clypeus flat, subquarrelly emarginated with truncate lateral lobes; deep circular pit in front of median ocellus present; frontal ridge confluent with low supra-antennal tubercle; circum- and interocellar furrows prominent; and postocellar area rectangular. Mesoscutellum obtusely raised.

Head with punctures on frons and postocellar area; mesonotum finely and densely punctured; mesoscutellum with setiferous punctures; metascutellum with micropunctuation; and mesopleuron with rugose punctures at the apex of mesepisternum. Lancet (Fig. 13) with about 23 serrulae, each flat with no anterior and indistinct posterior subbasal teeth.

Male: Unknown.

Holotype: Female, HIMACHAL PRADESH: Manali, Solang—2600 m, 21.vi.82.

Discussion: *T. antennata* sp. nov. runs in Malaise's key upto couplet number 40, and found to be close relative of *T. angustiannulata* Malaise but it can be

differentiated by the 3rd antennal joint longer than 4th (6:5) (subequal in *T. angustiannulata*, Fig. 6); presence of deep circular pit in front of median ocellus (absent in *T. angustiannulata*, Fig. 1); flat serrulae (Fig. 13) (somewhat pointed in *T. angustiannulata*, Fig. 12); and by coloration of the head, abdomen and legs. The species name pertains to the relative length of 3rd and 4th antennal joints.

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THREE NEW PHYTOSEIIDAE FROM INDIA (ACARI : MESOSTIGMATA)

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(This paper presents the descriptions of three new species of Phytoseiidae, viz. *Amblyseius* (*Amblyseius*) *indirae* sp. nov., *A. (Proprioseiopsis)* *synachattiensis* sp. nov. and *Typhlodromus* (*Amblydromella*) *sonprayagensis* sp. nov.

(Key words: new Phytoseiidae from India)

In this paper three new species of Phytoseiidae are described and illustrated. All the measurements given in the text are in microns.

1. *Amblyseius* (*Amblyseius*) *indirae* sp. nov. (Figs. 1-7)

Female: Dorsal shield smooth, 358 long, 224 wide, with 17 pairs of setae, all being small except j_1 , j_3 , s_4 , Z_5 and Z_4 , which are longer. Seta j_1 slightly shorter than j_3 , $z_2 = z_4$, $s_4 \geq Z_4$. Measurements of setae: j_1 -33, j_4 - j_6 , J_2 - J_5 extremely small, j_3 -36, z_2 , z_4 -6 each, s_4 -105, Z_1 -5, S_2 - S_5 -5-6 each, Z_5 -235, z_5 -5, Z_4 -100, r_3 , R_1 -10 each. Sternal shield as broad (90) as long, with 3 pairs of sternal setae, metasternal plates conspicuous with seta. Genital shield 67 wide with a pair of setae. Ventrianal shield longer (100) than broad (67), lateral margins concave with 3 pairs of preanal setae; a pair of crescent shaped preanal pores present slightly below the level of third pair of preanal setae; 4 pairs of setae present around ventrianal shield, JV_5 -56 long, 2 pairs of metapodal plates present, primary one 25 long, accessory one- 9 long. Spermatheca with long duct,

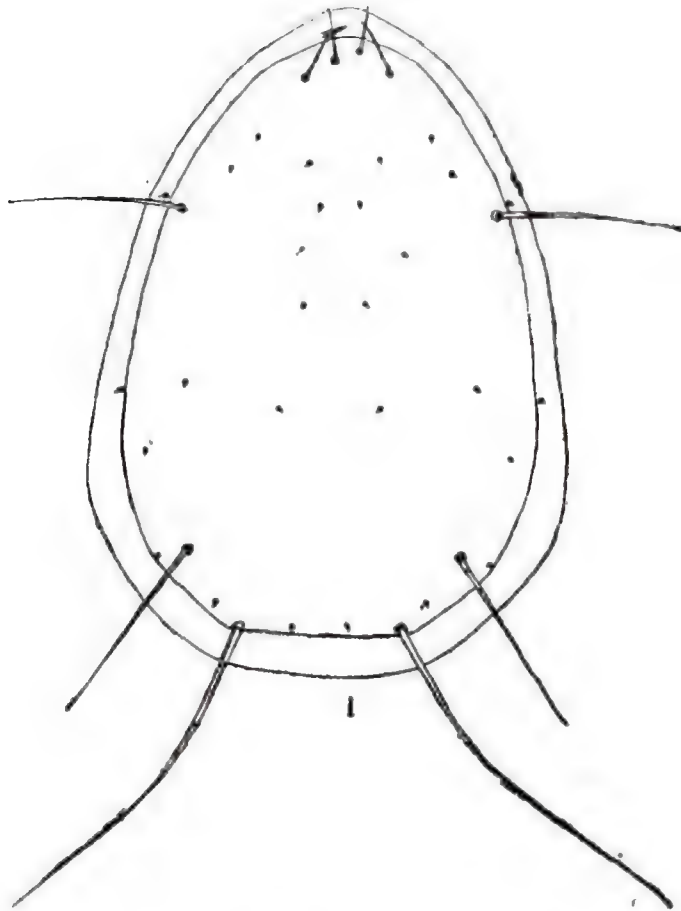
as figured. Fixed digit of chelicera with 4 teeth anterior to *pilus dentilis*, 4-5 teeth posterior to it, *pilus dentilis* strong; movable digit toothless. Macrosetae on leg IV: genu- 117, tibia- 94, basitarsus- 71, genu II-22, genu III- 34, Leg chaetotactic formula: genu II $2 \frac{2}{6} \frac{2}{0} 1$, tibia II $1 \frac{1}{1} \frac{2}{1} 1$, genu III $1 \frac{2}{1} \frac{2}{8} 1$, tibia III $1 \frac{1}{1} \frac{2}{1} 1$. Peritreme extends anteriorly upto j_1 .

Male: Dorsal chaetotaxy similar as in female. Spermatophoral process and ventrianal shield as figured.

Holotype: ♀, INDIA: Karnataka, Chikmagalur, Mudigere, on an undetermined plant, 30.xii.1980, Coll. S. K. Gupta, deposited in ZSI, Calcutta, Reg. No. 3351/17. **Paratypes** 2 ♀♀, 1 ♂, data same as for holotype, Reg. Nos. 3352-53/17.

Remarks: This species differs from *Amblyseius* (*A.*) *shiganus* Ehara (1972) in having vase-shaped ventrianal shield and in having comparatively shorter setae on dorsal shield. From *A. (A.) largoensis* (Muma, 1955) it differs in shape of spermatheca.

2. *Amblyseius* (*Proprioseiopsis*) *synachattiensis* sp. nov. (Figs. 8-11)



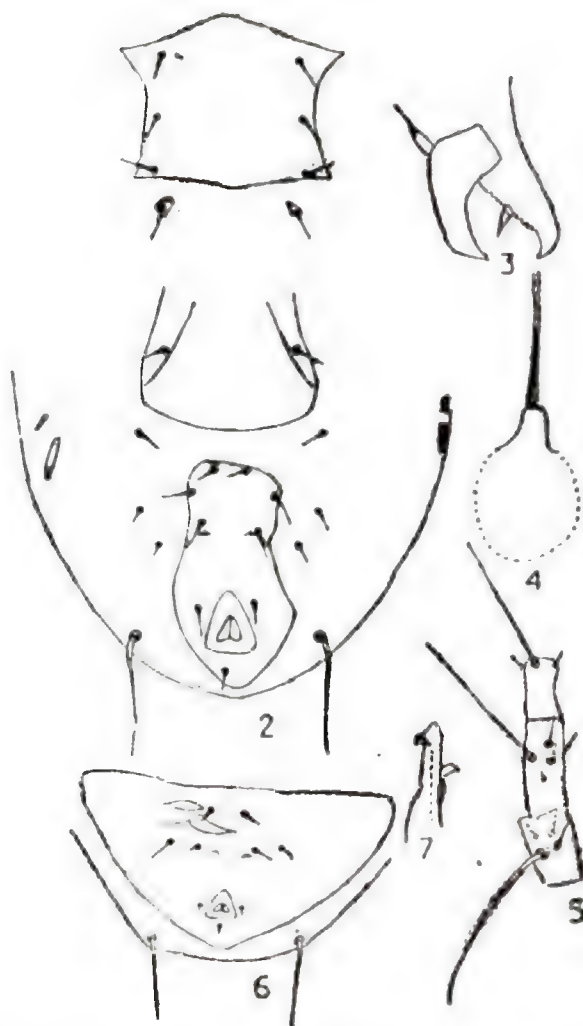
Figs. (1—7) *Amblyseius (Amblyseius) indirae* sp. nov. (Figs. 1—5) Female: 1—dorsal shield.

Female: Dorsal shield 504 long, 292 wide, rugose, with at least 8 pairs of pores and 16 pairs of setae, J_2 absent. Measurements of setae: j_1 -34, j_4 -5, j_5 -6, j_6 -20, J_5 -6, j_3 -54, z_2 -36, z_4 -52, s_4 -90, Z_1 -25, S_2 -18, S_4 -13, S_5 -16, Z_3 -121, z_5 -8, Z_4 -90, r_3 -31, R_1 -11, r_3 and R_1 both lie on lateral integument; all setae smooth. Sternal shield wider than long with 3 pairs of sternal setae, metasternal plates rounded with seta. Genital shield 125 wide, rugose, with a pair of setae. Ventrianal shield triangular, reticulate anteriorly, 157 long and as much wide, with 3 pairs of preanal setae and a pair

of round preanal pores; 4 pairs of setae and a pair of platelets present around ventrianal shield, JV_5 -26 long (smooth). Fixed digit of chelicera multidentate, movable digit with at least 3 teeth. Spermatheca with bell-shaped cervix, as figured Macrosetae on leg IV: genu- 20, tibia- 40, basitarsus- 34, all pointed; genu II and III also with macroseta. Leg chaetotactic formula: genu II $2 \frac{3}{0} \frac{3}{0} 1$, tibia II $1 \frac{1}{1} \frac{2}{1} 1$, genu III $1 \frac{2}{1} \frac{2}{0} 1$, tibia III $1 \frac{1}{1} \frac{2}{1} 1$.

Male: Unknown.

Holotype: ♀, INDIA: Uttar Pradesh, Garhwal region, Synachatti, on grass, 31.viii.



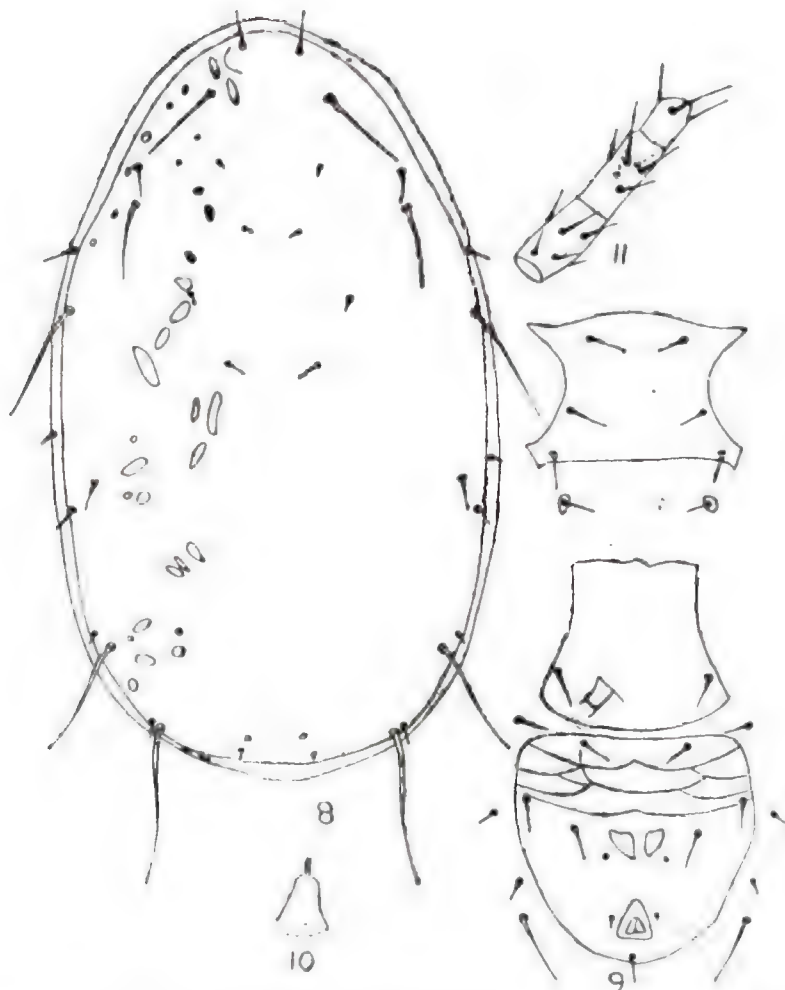
Figs. 2—ventral surface; 3—chelicera; 4—spermatheca; 5—genu, tibia and basitarsus of leg IV. *A. (A.) indirae* sp. nov. (Figs. 6—7) Male: 6—ventrianal shield; 7—Spermatophoral process.

1979, Coll. S. K. Gupta, deposited in ZSI, Calcutta, Reg. No. 3390/17.

Remarks: This species is very close to *Amblyseius (Proprioseiopsis) rotundus* (Muma, 1961) but differs in shape of spermatheca and in relative length of z_2 and z_4 . It is also close to *A. (P.) alpicola* Ehara (1982) but differs in shape of ventrianal shield and in relative

lengths of dorsal idiosomal setae. Further $Z_1 > S_2$ in this new species while in *alpicola* $Z_1 < S_2$. Lastly it is also near to *A. (P.) kogi* Chant & Hansell (1971) but differs in relative lengths of z_2 and z_4 and in shape of spermatheca.

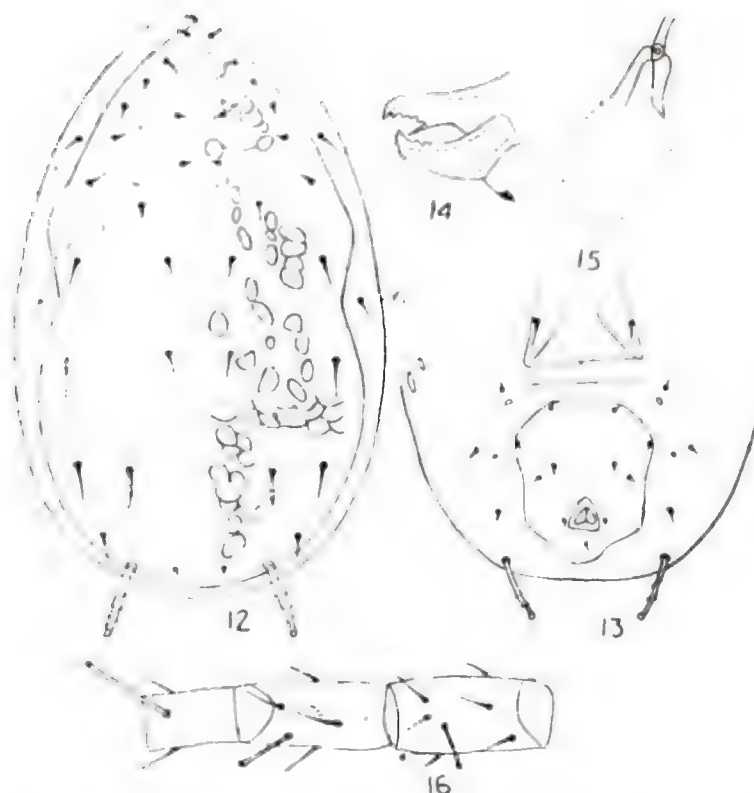
3. *Typhlodromus (Amblydromella) sonprayagensis* sp. nov. (Figs. 12—16)



Figs. 8—11. *Amblyseius (Propriozeiopsis) synachattiensis* sp. nov. Female: 8—dorsal shield; 9—ventral surface; 10—spermatheca; 11—genu, tibia and basitarsus of leg IV.

Female: Dorsal shield reticulate, well sclerotized, 360 long, 213 wide, with 18 pairs of setae. Peritreme extends anteriorly upto j_1 and slightly concave inwards, Z_4 about $\frac{1}{2}$ of the distance between Z_4 and S_5 ; Z_5 serrate, with knobbed tip, Z_4 only weakly serrate at tip. Measurements of setae: j_1 -14, j_4 -14, j_5 -16, J_2 -20, J_5 -6, j_3 -22, z_2 -16, z_3 -20, z_4 -18, s_4 -22, s_6 -22, S_1 -27, S_4 -27, S_5 -20, Z_5 -45, z_5 -16, Z_4 -25, r_3 -23, R_1 -18. Sternal shield margins indistinct, however, 3

pairs of sternal setae very distinctly visible. Genital shield 70 wide with a pair of setae, a fold present between genital and ventrianal shields. Ventrianal shield 112 long, 85 wide, with 4 pairs of preanal setae and a pair of preanal pores, 4 pairs of setae and 2 pairs of small platelets present around ventrianal shield, JV_5 -40 long (knobbed); 2 pairs of metapodal plates present, primary one 20 long, accessory one 7 long. Chelicera with 4-5 teeth anterior



Figs. 12—16. *Typhlodromus (Amblydromella) sonprayagensis* sp. nov. Female: 12—dorsal shield; 13—posterior ventral surface; 14—chelicera; 15—spermatheca; 16—genu, tibia and basitarsus of leg IV.

to strong *pilus dentilis*, movable digit with 3 teeth. Spermatheca as figured. Leg chaetotactic formula: genu II $2 \frac{2}{1}$, tibia II $1 \frac{1}{1} \frac{2}{1}$, genu III $1 \frac{2}{1} \frac{2}{1}$, tibia III $1 \frac{1}{1} \frac{2}{1}$. Macrosetae on leg IV: genu—14, tibia—16, basitarsus—35, all with knobbed tip.

Male: Unknown.

Holotype: ♀, INDIA: Uttar Pradesh, Sonprayag, on pear, 11.ix.1979, Coll. S. K. Gupta, deposited in ZSI, CALCUTTA, Reg. No. 3492/17. **Paratype:** 1♀, data same as for holotype, Reg. No. 3493/17. Holotype is mounted on left side of the

slide; paratype badly damaged on right side of slide.

Remarks: This new species is close to *T. (A.) galumnatus* (Chaudhri *et al.*, 1974) but differs in shape of spermatheca.

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INTRA-TREE DISTRIBUTION OF THE EGGS OF MANGO STONE WEEVIL, *STERNOCHETUS MANGIFERAE* (FABRICIUS) (COLEOPTERA : CURCULIONIDAE)

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Intra-tree distribution of the eggs of mango stone weevil, *Sternochetus mangiferae* (Fabr.) on Banganpalli cultivar of mango revealed that average number of eggs fruit were deposited maximum on the fruits in the lower region of tree i.e., up to two metres height. With the increase in tree height, the egg deposition on fruits decreased. Statistically no differences were observed in average number of eggs fruit deposited in North, South, East and West directional quadrants. On the fruit, maximum eggs were deposited in the sinus region as compared to area around pedicle or rest of the fruit area. The linear regression line of egg population in sinus region on fruit with total egg population was: $Y = 0.5175 + 0.6972 X$. The Coefficient of determinant explained 82 per cent variation of the total egg population on the fruit.

(Key words: intra-tree distribution, linear regression, *Sternochetus mangiferae*)

INTRODUCTION

The mango stone weevil, *Sternochetus mangiferae* (Fabr.) is one of the serious and specific insect pests of mango. It is cosmotropical in distribution and is reported to occur in India, Bangladesh, Pakistan, Burma, Malaysia, Philippines, Thailand, Indonesia, Japan, Vietnam, Mauritius, Tanzania, Uganda, Mozambique, South Africa, Queen'sland and Hawaii (CIE map No. A-180). LEFROY, (1906) was the first to report *S. mangiferae* as pest of mango from India and described briefly its life history and damage. At present, the pest is quite serious in Eastern and Southern parts of Indian Peninsula (TANDON, 1978) and has become a major constraint in the

export of fresh fruits. The female weevils oviposit singly in the fruit epicarp and freshly hatched grubs bore through the mesocarp to enter into seed wherein they feed in a zig-zag fashion and finally destroy the cotyledons completely. The development is completed inside the stone and only adult weevils emerge out by cutting circular holes in the ripened fruits.

Although sufficient literature is available on the biology and control of mango stone weevil (BALOCK & KOZUMA 1964; SUNDARA BABU, 1966; SEO *et al.*, 1970; RAO *et al.*, 1971; KOK, 1979), information on intra-tree distribution is completely lacking. The present studies were conducted on intra-tree distribution of the eggs of this pest to devise a population sampling scheme and to improve the efficiency of pest management programme.

MATERIALS AND METHODS

Studies on intra-tree distribution of the eggs of *S. mangiferae* were conducted in a mango orchard at Experimental Station, Hesaraghatta of Indian Institute of Horticultural Research, Bangalore on Banganpalli cultivar during, 1983. Ten trees, 15–18 years old having an average height of 6–7 metres were selected for this study and kept free of insecticidal sprays during the period under study.

Egg distribution in relation to tree height: Each tree under study was divided into three regions according to height i.e., lower region (0–2m), middle region (2–4m) and upper region (4–6m). Twenty five fruits were selected randomly from each region. Observations on egg population/fruit were taken under 10× magnifying glass. Similar observations were taken on all the ten trees. The data were subjected to analysis of variance.

Egg distribution in relation to tree direction: The same ten trees were sampled to determine whether any difference existed in egg distribution among four compass directions (NSEW). Each tree was divided into four directional quadrants and from each quadrant 25 fruits were selected randomly for observations on egg population. On each fruit eggs were counted as per procedure mentioned earlier and data were subjected to analysis of variance.

Egg distribution on fruit: In order to study the egg distribution on a fruit, and to know

whether a particular area on a fruit is preferred for oviposition, the whole fruit was divided into three regions i.e., around pedicle, around sinus and rest area. Total hundred fruits were selected from five hundred fruits harvested from these trees at random, covering different heights and directions. On each fruit number of eggs deposited in each area defined above were counted separately. The eggs included both fresh eggs as well as hatched. The statistical analysis was carried out for prediction and estimation of population on different parts of fruit.

RESULTS AND DISCUSSION

Egg distribution in relation to tree height: The data on distribution of *S. mangiferae* eggs in relation to tree height are presented in Table 1. The perusal of data indicated that there existed a highly significant difference in egg population in three different regions. Maximum number of eggs were deposited on the fruits in lower tree region, followed by fruits in middle and upper regions. Consistently, same trend was observed in all ten trees. The average number of eggs/fruit in lower tree region varied from 5.04 to 10.40 in different trees. In the middle region the average egg population/fruit ranged from 3.08

TABLE 1. Distribution of *S. mangiferae* eggs in relation to tree height.

Height	Set No.	Mean number of eggs deposited per fruit									
		1	2	3	4	5	6	7	8	9	10
Lower Region (0–2m)		10.40	8.04	8.36	7.36	9.52	7.00	9.60	9.32	5.04	6.12
Middle Region (2–4m)		5.56	5.76	5.72	5.03	4.44	3.84	4.68	5.04	3.36	3.08
Upper Region (4–6m)		4.48	2.64	2.40	3.28	2.96	2.52	3.32	3.36	2.36	1.64
CD 5%		2.84	2.15	2.41	1.66	1.79	1.35	1.76	2.02	1.35	1.30
CD 1%		3.80	2.88	3.22	2.22	2.89	1.80	2.35	2.70	1.81	1.74

difference was observed in mean number of eggs/fruit in different directions. Similar trend was observed in all the trees under study. This indicates that weevils disperse randomly to all the directions for oviposition from main tree trunk where they over-winter. MORRIS (1955) also reported no significant differences in eggs and larval population of spruce bud worm (*Choristoneura fumiferana*) in different sides of the same tree. However MAC LELLAN (1962) noticed that early part of season, the codling moth lays mostly eggs on the south-east of apple tree but later this bias disappears.

Egg distribution on fruit: Data on distribution of eggs of stone weevil on fruit presented in Table 3 revealed that maximum average number of eggs were deposited around sinus region followed by rest area on fruit while minimum in an area around pedicle. The differences in egg number per fruit in different areas were statistically significant at 1% level. Further, linear regression line of egg population in sinus region on fruit with total egg population was: $Y = 0.5175 + 0.6972 X$. The coefficient of determinant explained 82 per cent variation of total egg population within fruit.

[illegible]

TABLE 3. Distribution of stone weevil eggs on fruit.

Sl. No	Position on fruit	Av. no. eggs/fruit
1	Sinus region	7.82
2	Pedicle region	0.16
3	Other region	2.44
	CD 5%	0.72
	CD 1%	0.95

From the studies it can be concluded that maximum oviposition on mango fruits is done in lower tree region (upto 2m) and with increase in height the extent of oviposition decreases. Further, tree directions have no influence on egg distribution. Thus, while planning strategies for its management maximum care should be taken in lower region all around the trees. Also during sampling of fruits for the weevil appropriate weightage should be given to lower region. In this case where the distribution is biased towards lower region, if samples are taken randomly from whole tree systematic errors will arise (LE ROUX & REIMER, 1959). Therefore, for suitable sampling plan, the tree should be stratified according to height regardless of directions for precise estimate of pest population.

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PREDICTION OF THE CABBAGE APHID, *BREVICORYNE BRASSICAE* (L.) PEAKS ON CAULIFLOWER SEED CROP FROM THERMAL UNIT ACCUMULATIONS

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The cabbage aphid, *Brevicoryne brassicae* (L.) population build up was monitored on the cauliflower seed crop to establish the relationship of thermal unit accumulations (= day-degrees) with the peak aphid infestation. A day-degree (D°) requirement of 691.3 ± 12.8 (5°C base) was found to coincide with the peak populations of aphid in the cauliflower seed crop ecosystem during 1979-1980 and 1980-1981. The D° requirement was confirmed in two successive cropping seasons indicating fairly high predictive value of the thermal unit system.

(Key words: thermal unit accumulation, day-degrees, *Brevicoryne brassicae* (L.), prediction)

The cabbage aphid, *Brevicoryne brassicae* (L.) is the most important limiting factor in the successful cultivation of late season cauliflower *Brassica oleracea* L. var. *botrytis* L. (Snowball group) grown for seed production in the north-west Himalayas (BHALLA & PAWAR, 1977; VERMA & BHALLA, 1978). The cabbage aphid is present on the crop almost throughout the growing period of the crop and the population rises to give a unimodal peak (TANDON *et al.*, 1977). To ensure a pest free crop, seed growers resort to calendar based applications of pesticides. This is so because there is no method by which *B. brassicae* build up could be predicted to a reasonable accuracy and time insecticidal applications. Experiments were, therefore

carried out to develop a prediction method through the use of correlation between accumulation of heat units above a threshold and insect development as proposed by LINDSEY & NEWMAN (1956), ARNOLD (1960), BASKERVILLE & EMIN (1968). This relationship has already been established for a few insect pests of vegetable crops like cabbage maggot (ECKENRODE & CHAPMAN, 1972), onion maggot (ECKENRODE *et al.*, 1975), diamondback moth (BUTTS & MC EWEN, 1981), and for cereal aphid (BA ANGOOD & STEWART, 1980). But any such relationship is lacking for this aphid. The experiments carried out for two cropping seasons, 1979-1980 and 1980-1981, were evaluated for two subsequent seasons (1982 & 1983) for testing the validity of these estimates.

MATERIALS AND METHODS

The trials were laid out at the university farm at Nauni, Solan, Himachal Pradesh (1200 m.a.s.l.). The cauliflower (cv. Snowball-16

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seedlings were transplanted during mid October in all the four seasons reported in this communication. All the recommended agronomic practices were followed to raise the crop except the plant protection measures which enabled the build up of aphid population in a pesticide free environment. Care was taken to crush egg masses of *Pieris brassicae* (L.), another important insect which competed the aphid for food.

The aphid counts were made at weekly intervals from 10 plants selected at random from the experimental field accommodating 600-800 plants transplanted at 45 × 45 cm spacing. During the vegetative growth stage the sample size comprised of 3 leaves (one each from the inner, outer and outermost whorl). At bolting, three terminal bolts (flowering shoots), about 10 cm long, selected at random per sample plant, served as one sample as followed by TANDON *et al.* (1977), DHALIWAL & GOMA (1979). Initially, when the population was low (October to December), the counts were made on the leaves *in situ*. However, when the aphid number became high, leaf as well as bolt samples were obtained in muslin cloth bags and brought to the laboratory where they were given heat treatment at 49°C for 40 to 45 minutes to dislodge the aphids as described by HUGHES (1963). The aphids were then shaken out of the bag and collected in tubes containing 70% ethanol to be counted later. The temperature data were recorded daily from maximum-minimum thermometers housed inside weather shelter near the experimental field. Data on the rainfall were also recorded.

The day-degrees corresponding to aphid numbers were computed by using the formula given by LINDSEY & NEWMAN (1956):

$$\text{Day-degrees (D}^\circ\text{)} = \frac{h+m}{2} - t \quad t < m$$

$$= \frac{(h-t)^2}{2(h-m)} \quad m < t < h$$

where, h = maximum temperature, m = minimum temperature, and t = threshold temperature. The threshold temperature of 5°C, as established by HUGHES (1963) for *B. brassicae*, was used for calculating the temperature accumulation to peak numbers of the aphid in the seed crop ecosystem.

RESULTS AND DISCUSSION

The alate cabbage aphids were first observed in yellow pan water traps installed in the plot about 7 to 20 days earlier than their first detection on the crop in small colonies of apterous insects on November 2, 1979 and November 19, 1980. The day-degrees summed up from the dates of first detection of aphid colonies on the crop in both the years until the dates of peak occurrence, are given in Table 1. The data reveal that *B. brassicae* reached its peak on the accumulation of 704.1D° (5°C base) by February 24, in the first season when the population averaged 3489.1 per sample. Whereas, in the second season, the peak population (445.7/sample) occurred on February 17, on the accumulation of 678.5 D°. A great variation in the peak number of aphid reached during two consecutive cropping seasons could be explained on the basis of circumstantial evidence that in the second season, aphid population could not build up due to heavy winter rains which are normally wanting in the region where these studies were carried out. Several reports exist to point out adverse effect of rainfall on aphid multiplication (HUGHES, 1962, 1963; VAN EMDEN *et al.*, 1979) as has been observed in the present findings. Keeping this data in view, the average requirement of 691.3 D° ± 12.8 (5°C base) was worked out for the peak population of *B. brassicae*. In a similar study with the cereal aphid, *Sitobion avenae* (F.), BA ANGOOD & STEWART (1980) reported a day-degree accumulation of 543D° (5°C base) or 339D° (10°C base) for the peak population of aphids infesting small grain crops.

The day-degree data were tested in two subsequent seasons, 1982-1983 and

TABLE 1. Observed day-degree (D°) accumulations and population build up after first detection of *B. brassicae* on cauliflower seed crop at Solan during 1979–1980 and 1980–1981.

Sampling date	Cropping Season			
	1979–1980*		1980–1981**	
	Accumulated D° after first detec- tion on crop	Mean aphids per sample	Accumulated D° after first defec- tion on crop	Mean aphids per samples
November 4	36.6	16.2	—	—
11	116.5	13.8	—	—
18	194.1	22.2	50.2	17.3
25	256.6	25.6	123.2	37.0
December 2	316.0	59.4	186.4	110.0
9	356.4	82.6	242.4	42.0
16	389.6	223.6	284.1	71.0
23	415.8	447.8	339.4	188.0
30	461.9	363.7	380.4	186.4
January 6	483.7	897.6	420.7	187.4
13	503.0	1486.0	442.7	360.1
21	525.3	1658.8	488.2	431.3
27	562.5	1395.6	527.1	189.5
February 3	594.1	2219.8	566.4	197.2
10	616.8	2626.6	588.0	421.2
17	653.8	3117.6	678.5	445.7
24	704.1	3489.1		
Mean D°	691.3 \pm 12.8 (5°C base)			

* The aphid infestation was first detected on November 2, 1979. ** The aphid infestation first detected on November 14, 1980.

1983–1984, for examining the validity of the estimates. The data presented in Table 2 show that the population peaks were uniform in both the seasons and that in the year 1982–1983, peak population occurred on March 22 at the accumulation of 728.3 D° , whereas, the same was predicated for March 19. In the year 1983–1984, peak occurred on March 15 at the accumulation of 678.3 D° when the peak was predicted for March 20. The observed variations may be due to variable response of

natural enemies and other climatic factors in the seed crop ecosystem.

The results show that although there is variation, this variation is not so great as to make the day-degree data unsuitable for predicting peak incidence of this aphid. This method can be further refined to work out D° requirements of aphids at various threshold populations. This will help in making more efficient use of insecticides for the control of this insect.

TABLE 2. Occurrence of *B. brassicae* peaks on the basis of plant sampling and predicted by day-degree (D°) accumulations at Solan during 1982—1983 and 1983—1984.

Cropping season	D° accumulation at the time of peak population*	Mean number of aphids at peak population	Date	
			Observed	** Expected
1982—1983	728.3	3295.8	March 22	March 19
1983—1984	678.3	2704.6	March 15	March 20

* The aphid infestations were first detected on November 11 and November 1 in 1982—1983 and 1983—1984, respectively. ** Based on day-degree above a threshold of 5°C.

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TAXONOMIC STUDIES ON THE MEMBRACIDAE OF SOUTHERN INDIA (HOMOPTERA : INSECTA)-I

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(Received 21 September 1984)

Five new species of membracids, *Telingana sabarigiriensis*, *Pogonotus indicus*, *Aleptocentrus notabilis*, *Tricentrus distinctus* and *T. speciosus*, belonging to the subfamily Centrotinae, collected from Sabarigiri, Western Ghats, Kerala, are described, and the incidence of *Anchon ulniforme* Buckton and *Tricentrus congestus* (Walker) is reported. One new Tribe, Aleptocentrini and two new genera, *Pogonotus* and *Aleptocentrus*, are erected.

(Key Words: Taxonomy-Membracidae)

The material included in the present paper was collected during an expedition by the Southern Regional Station of Zoological Survey of India to Sabarigiri (Western Ghats, Kerala), and includes one new tribe, one new genus and three new species. Some of the materials in the present study are represented by unique specimens, but they display differences sufficient enough to indicate their distinction.

Capener (1968) pointed out that the basic error in the system of classification of Membracidae by early authors was the separation of higher categories such as the Tribes based on the presence or absence of the suprahumeral horns; this is due to the fact that the suprahumeral horns exhibit very wide variations, being absent in some and well developed in others belonging to the same species; further, some species are sexually dimorphic, the males having reduced horns or no horns, while the females having well developed horns, and this situation

may lead to the allocation of the two sexes to different species or to different genera. In many species and genera, however, the horns vary within narrow limits and hence taxonomically important. It may be mentioned here that the degree of development of the scutellum appears to be relatively constant at the specific levels. Hence, in the present study, the scutellum is also considered in the classification of the Tribes of the local Centrotinae.

Subfamily : CENTROTINAE

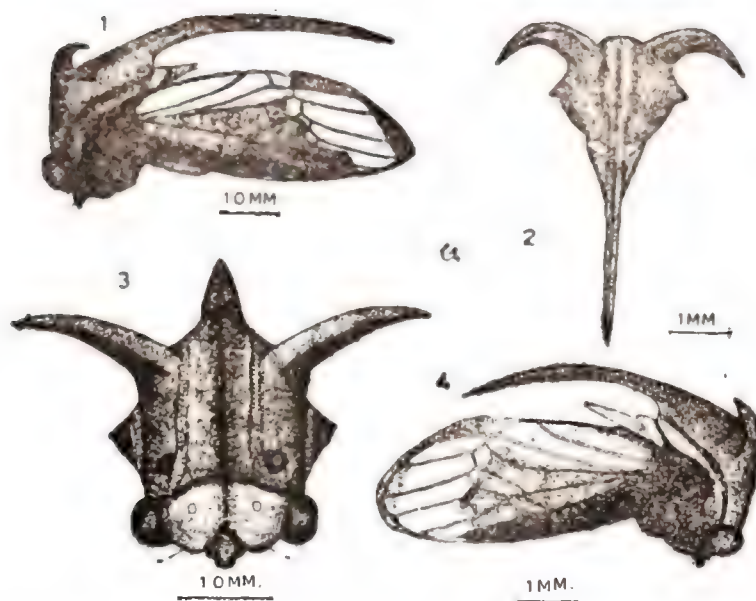
Tribe : Leptocentrini

Genus : *Telingana* Dist.

***Telingana sabarigiriensis* sp. nov. (Fig. 1-4)**

Female: General colour piceous; vertex shining black, almost 2.5 times as wide as long, punctate, with thickly crowded short golden pilosity; upper margin of vertex more or less planate, eyes large, subglobose, brownish; ocelli shining white, conspicuous, nearer to eyes than to each other and situated well above the centro-ocular line; frontoclypeus black, extending about three-fourth of its length beyond lower margin

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Figs. 1—4 *Telingana sabarigiriensis* sp. nov. 1. Lateral view of female 2. Dorsal view of female pronotum and scutellum 3. Frontal view of female 4. Lateral view of male

of vertex, thickly hairy, tip broadly round; frontoclypeal lobes distinct, partially fused. Pronotum piceous, strongly punctate, with short golden hairs sparsely distributed; a pair of white tomentose line extending from base of metopidium to base of posterior pronotal process, and another pair of similar lines bordering the bases of humeral angles anteriorly and dorsally; metopidium vertical, convex, about 1.5 times as wide as high; supra-ocular callosities black, almost bare; supra-humeral horns black, robust, with short sparse golden pilosity, 1.5 times as long as distance between their bases, viewed from sides directed forward and strongly curved backward, viewed from above prominently carinate and directed laterad and caudad, viewed from front directed obliquely upwards and outwards, lateral and posterior surfaces of horns strongly punctate;

posterior pronotal process slender, moderately stout at base, directed almost horizontally caudad slightly arched, highest above scutellum, emerging obliquely behind disc and vertically from posterior margin of disc, never impinging on the tegmina, tip gradually acuminate, reaching the tip of 5th apical cell of tegmina, pronotum cretaceously sericeous on each side; scutellum triangular twice as long as broad, basal part swollen, clothed with dense white tomentosity, apical two-thirds almost planate, punctate with sparse golden pilosity, tip with U-shaped emargination, apices acute. Tegmina thrice as long as wide, brownish amber hyaline, costal area dark, coriaceous, costal, radial, median and cubital veins, 1st discoidal, three-fourth of 2nd discoidal, 1st apical and basal half of 2nd apical cells dark brown, sparsely pilose, apical limbus narrow,

bronzy, R_1 oblique, 1st apical cell based on radial sector, about 1.5 times as long as its greatest width, 2nd discoidal cell one and a half times longer than 1st. Legs with femora, black, tibiae dark brown, tarsi light brown, claws dark brown.

Measurements: Length from frontal margin to tip of tegmina 6.58 mm, to tip of posterior process 5.9 mm; width across tips of suprahumeral horns 4.61 mm, at humeral angles 2.52 mm, at eyes 2.3 mm.

Male: Slightly smaller than female; coloration similar to female; posterior process shorter than female, just reaching the basal third of 5th apical cell of tegmina.

Measurements: Length from frontal margin to tip of tegmina 6.4 mm, to tip of posterior process 4.85 mm; width across tips of suprahumeral horns 4.43 mm, at humeral angles 2.6 mm, at eyes 2.2 mm.

Materials examined: Holotype female from Pepparai, Sabarigiri, Kerala; 420 meters. Collected by G. Thirumalai; 11.v.1981. Paratype male from Vettiar, Sabarigiri, Kerala, 520 metres; coll. R. S. Pillai, 9.v.1981.

Distribution: India, Kerala.

Remarks: This species is closely related to *T. majescula* Thirumalai & Ananthasubramanian (1981) in the general size and coloration, but differs in the strongly recurved suprahumeral horns, in the less arched posterior process, and in the presence of a pair of white tomentose lines extending from the base of the metopidium to the base of the posterior process and by another pair of white tomentose lines at the base

of humeral angles on their anterior and dorsal aspects,

Pogonotus gen. nov,

This genus is close to *Pogon* Buckton (1903) in the strongly curved apical veins of tegmina, but differs in the nature of the pronotal posterior process which is long, quite remote from scutellum and never impinging on the inner angles of tegminal margin; the posterior pronotal process is robust and wavy.

Head vertical, about thrice as wide across the extremities of eyes as length of vertex, upper margin arcuate and weakly sinuate, lower margins oblique to frontoclypeus and sinuate; eyes globate, ocelli closer to eyes than to each other and situated above the centro-ocular line; frontoclypeus declivous, longer than broad, extending about a half of its length below the lower margin of vertex. tip broadly rounded, frontoclypeal lobes distinct extending only about half of the length of the frontoclypeus and very slightly below the lower margins of vertex. Pronotum convex, slightly high behind disc; metopidium vertical and a little backwardly sloping to disc, one and a half times as wide as high; humeral angles prominent, their tips acute; suprahumeral horns well developed, robust, tricarinate, directed obliquely upward and outward, tips acute; posterior process emerging well behind horns, tricarinate, well elevated above scutellum, moderately stout, wavy, remote from inner tegminal margin, gradually backward, reaching the tip of abdomen, tip acute; scutellum twice as long as wide; tegmina about three times as long as wide, without pterostigma, with 5 apical cells and two discoidal

cells, apical veins strongly curved; 1st discoidal cell not parallel-sided, R1 oblique to radial sector; 1st apical cell about 4.5 times as long as its greatest width, apical limb narrow.

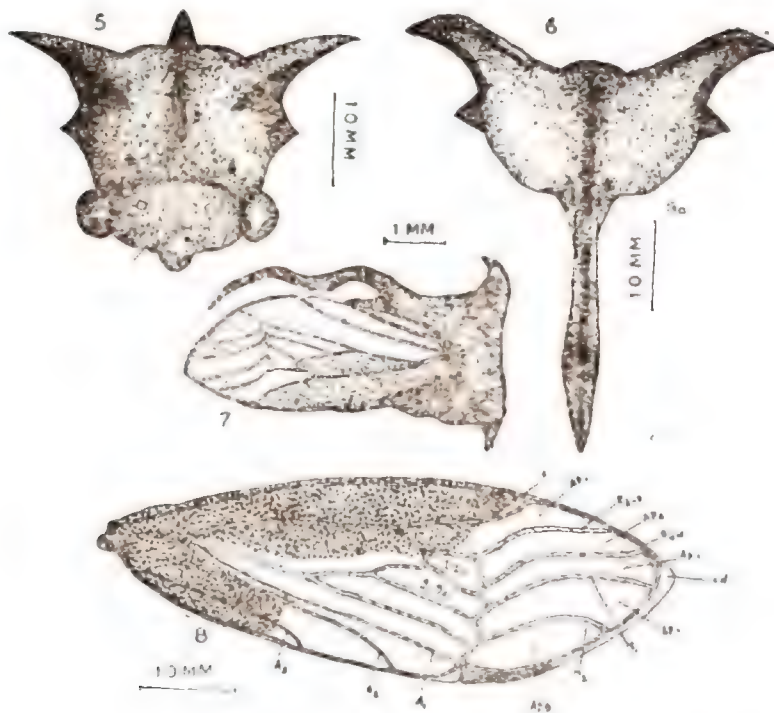
Type of the genus *Pogonotus indicus* sp. nov.

***Pogonotus indicus* sp. nov. (Figs. 5-8)**

As in the generic description, with the following additional characters.

Female: General colour rusty brown. Vertex shining brown, punctate with short golden pilosity. Eyes buffy brown; ocelli succineous; frontoclypeal margin black, with sparse long hairs; metopidium shining brown, supraocular callosities bare, undivided; superahumeral horns

dark brown, broad at base, sprinkled with short silvery hairs a little longer than the distance between their bases, carinae black; viewed from sides directed obliquely forwards with the tips curved backwards, viewed from front directed upward, then outward and then backward; viewed from above directed upwards with the terminal parts directed backward. Posterior process brown, tip black, with sparse golden pilosity; scutellum with long adpressed hairs; tegmina bronzy brown, apical veins R2+3, R4+5, M1 and M2 strongly curved inwardly; 1st discoidal cell half as long as the 2nd, basal one-sixth coriaceous, costal, radial and median sectors with thick dark spots. Leg



Figs. 5-8 *Pogonotus indicus* sp. nov. 5. Frontal view of female 6. Dorsal view of female pronotum and scutellum 7. Lateral view of female 8. Tegmina of female

with femora brown rest pale yellow. Abdomen brown with long white hairs.

Measurements: Length from frontal margin to tips of tegmina 5.19 mm, to tip of posterior process 4.67 mm; width across tips of suprahumeral horns 3.9 mm, at humeral angles 2.67 mm, at eyes 2.37 mm.

Male: unknown.

Material examined: Holotype female collected from Pepparai, Sabarigiri, Kerala, altitude 420 meters; coll. G. Thirumalai, 11.v.1981.

Distribution: INDIA, KERALA.

TRIBE : ALETOCENTRINI nov.

This tribe is erected to accommodate those Centrotinae which possess four apical cells in the hind wings, partially exposed scutellum which is reduced in the middle, being almost abortive, and the pronotum lacks suprahumeral horns. The tribe is closely related to Cocco-sterphini in the nature of the posterior process and tegminal venation.

ALEPTOCENTRUS gen. nov.

This genus may be distinguished by the total absence of suprahumeral horns, the long, sinuate posterior pronotal process surpassing the inner angle of tegmina and never impinging the inner margins of the tegmina, besides the presence of 4 apical cells in the hind wings; tegminal apical veins R_{2+3} and R_{4+5} are strongly curved towards the costal margin, while M_1 and M_2 are curved towards the cubital vein; scutellum much reduced in the middle.

Head vertical, about two and a half times wider across extremities of eyes than the length of vertex; upper margin

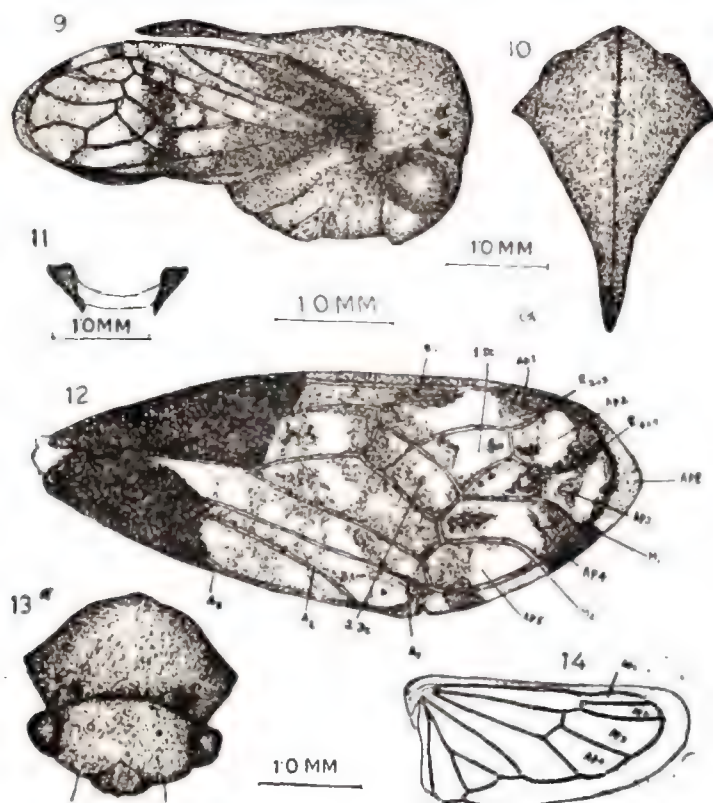
moderately arcuate and weakly sinuate, lower margins oblique; eyes globate; frontoclypeus extending two-thirds of its length below the lower margins of vertex; pronotum elevated at disc; humeral angles prominent, blunt; posterior process short, moderately concavely sinuate, contiguous with scutellum; scutellum partially exposed; tegmina two and a half times as long as wide, lacking pterostigma, with five apical cells and two discoidal cells; apical limbus moderately broad. Hind wings with four apical cells.

Type of the genus *Aleptocentrus notabilis* sp. nov.

Aleptocentrus notabilis sp. nov. (Figs. 9-14)

As in the generic description, with the following additional characters:

Female: General colour dark brown with shades of black; vertex black, finely punctate, with long golden hairs; eyes dull brownish; ocelli dark brown, conspicuous, closer to eyes than to each other and located above the centro-ocular line; frontoclypeus declivous, adpressed golden pilosity scattered all over, and obscuring the lines of fusion of frontoclypeal lobes; pronotum dark reddish brown, punctate with adpressed golden pilosity; metopidium vertical, gradually sloping backward to the disc, twice as wide as high, median carina percurrent to half of pronotum, inconspicuous on metopidium; supraocular callosities bare, divided; posterior process dark brown, sparsely pilose, slightly concave and moderately gibbous near its apex, passing backward a little beyond the claval area, never impinging the inner tegminal margin, tip reaching the base of the 5th apical cell. Tegmina



Figs. 9—14. *Aleptocentrus notabilis* sp. nov. 9. Lateral view of female 10. Dorsal view of female pronotum 11. Scutellum 12. Tegmina 13. Frontal view of female 14. Hind wing

light brown, basal third coriaceous, veins moderately thick, dark yellow, with pale virescent markings admixed with irregular brown patches; apical limbus pale white; 1st apical five times as long as its greatest width; 1st discoidal cell quadrangular, 2nd discoidal cell about one and a half times longer than the 1st; small tubercles sparsely arranged on veins. Abdomen and legs dark brown marooned with black; ovipositor pitch black.

Measurements: Length from frontal margin to tips of tegmina 4.53 mm, to tip of posterior process 3.3 mm;

width across tips of humeral angles 2.1 mm, at eyes 1.37 mm.

Male: Unknown.

Material examined: Holotype female, from Sabarigiri, Western Ghats, Kerala altitude 440 meters; collected by R. S. Pillai & G. Thirumalai, 6.v.1981.

Distribution: INDIA, KERALA.

TRIBE: CENTROTINI Goding

Genus *Anchon* Buckton, 1903

Anchon ulniforme Buckton

1903. *Anchon ulniforme* Buckton, *Monogr. Membracidae*, p. 214.

908. *Anchon ulniforme* Buckton: Distant, *Fauna of British India*, Vol. 4, p. 50.

One female from Sayabukuzhi, Sabarigiri, Kerala, altitude 320 metres; collected by R. S. Pillai, 1.v.1981.

Distribution: INDIA: KARNATAKA, KERALA; MALAYA.

TBIBE: TRICENTRINI Ahmad & Yasmeen, 1974

Genus *Tricentrus* Stal

Tricentrus congestus (Walker)

1858. *Centrotus congestus* Walker, *Ins. Saund., Hom.* 79.
 1908. *Tricentrus congestus* Walker: Distant, *Fauna. Brit. India*, 4:34.
 1934. *Otaris congestus* Walker: Goding, *J. N.Y. Ent. Soc.*, 42:480.
 1975. *Tricentrus congestus* Walker: Ananthasubramanian & Ananthakrishnan, *Rec. Zool. Surv. India*, 68:231.
 1981. *Tricentrus congestus* Walker: Thirumalai & Ananthasubramanian, *Bull. Zool. Surv. India*, 4:32.

One female from Pepparai, Sabarigiri, Kerala; altitude 420 mts., collected by G. Thirumalai, 11.5.1981.

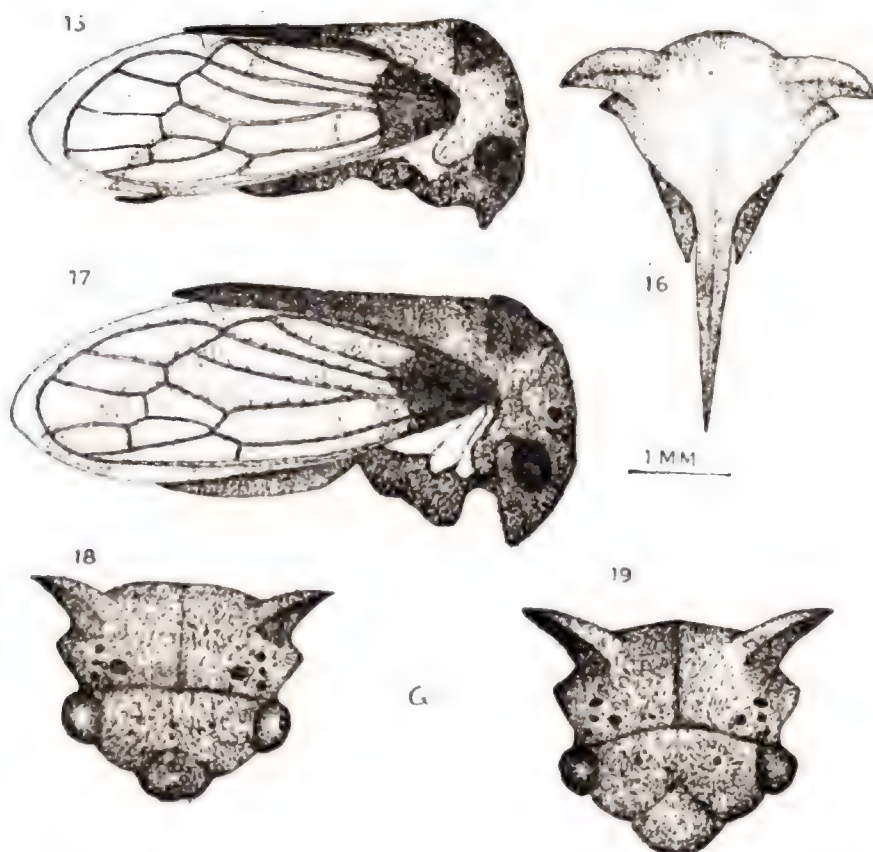
Distribution: INDIA: Kerala, Sikkim, Tamil Nadu, West Bengal, Malaya.

Tricentrus distinctus sp. nov. (Figs. 15—19)

Female: General colour reddish brown with shades of black. Head vertical, vertex about three times wider than long, finely punctate with long, adpressed golden hairs, upper margin arcuate and slightly sinuate, lower margin obliquely curved into frontoclypeus; frontoclypeus extending half of its length beyond the lower margins of vertex, tip broadly rounded and covered with long silvery pilosity; frontoclypeal lobes fused throughout their length; eyes sub-globate, brown

with shades of black; ocelli dark brown, closer to eyes than to each other and situated well above the centro-ocular line. Pronotum dark reddish brown with shades of black, finely punctate, with long golden hairs, median carina percurrent through metopidium; metopidium slightly obumbrant and vertical, a little more than twice as wide as high; humeral angles prominent, tips subacute; supra-ocular callosities pitch black, bare, divided; suprahumeral horns robust, broad-based, dark brown, tips black, slightly shorter than the distance between their bases, tricarinate, viewed from sides directed upward and moderately recurved, as seen from front directed outwards and then upwards, as viewed from above moderately broad, subobliquely curved backward; posterior process robust, emerging behind disc, contiguous with scutellum and inner angles of tegmina, basal part dark brown, terminal part jet black, tip acuminate, reaching a little beyond claval suture, strongly tricarinate, with suberect golden pilosity. Tegmina shining bronzy brown, three times as long as wide, basal one-fourth coriaceous, dark brown, tip broadly rounded, veins dark brownish, hairy, apical limb broad, 1st apical cell about 6 times as long as its greatest width, 1st discoidal cell not petiolate, as long as the 2nd discoidal cell; lateral areas of sternum cretaceously sericous. Legs with femora jet black, rest dark brown, hind trochanters prominently toothed on the dilated inner surface. Abdomen black with white pubescence; ovipositor dark brown.

Measurements: Length from frontal margin to tips of tegmina 5.71 mm, to tip of posterior process 4.21 mm; width across tips of suprahumeral horns 3.1 mm,



Figs. 15—19 *Tricentrus distinctus* sp. nov. 15. Lateral view of male pronotum and scutellum 16. Dorsal view of female pronotum and scutellum 17. Lateral view of female pronotum and scutellum 18. Frontal view of male head 19. Frontal view of female head

at humeral angles 2.47 mm, at eyes 2.38 mm.

Male: Similar to female, but smaller; general colour dark brown.

Measurements: Length from frontal margin to tip of posterior process 3.39 mm, to tips of tegmina 5.03 mm, width across tips of suprahumeral horns 3.06 mm, at humeral angles 2.44 mm, at eyes 2.27 mm.

Material examined: Holotype female, allotype male, collected from South east of Pamba travellers Bangalow, Sabari-

giri, Kerala, altitude 960 metres, collected by R. S. Pillai, 28.iv.1981.

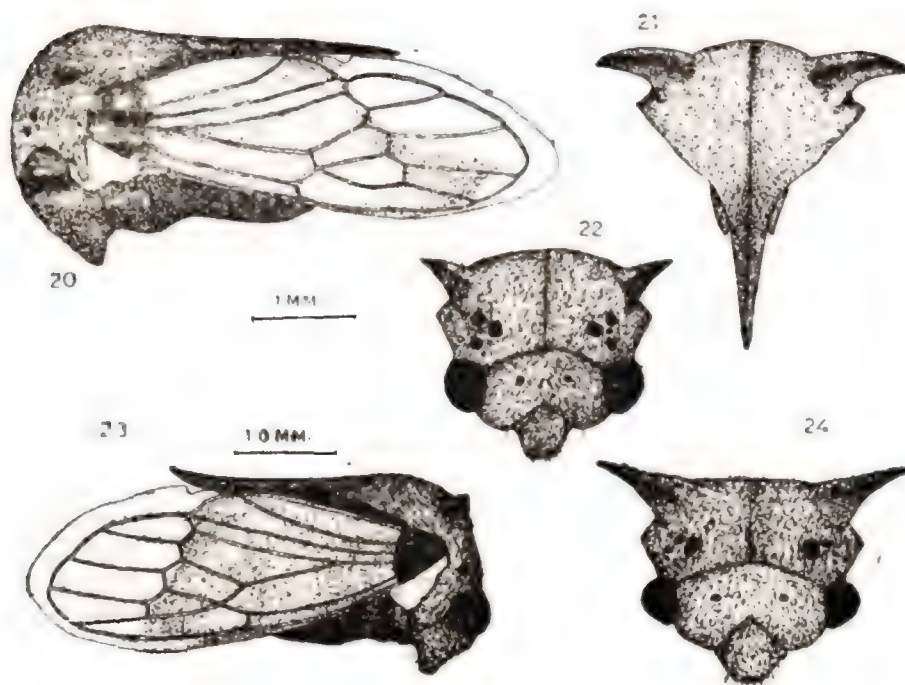
Remarks: This species is nearest to *I. pilosus* Ananthasubramanian & Ananthakrishnan in the general coloration and disposition of horns, but differs conspicuously in the less pilose body and in the dimensions of the discoidal cells of the tegmina; in *pilosus* the 2nd discoidal cell is distinctly shorter than the first discoidal cell, while in *T. distinctus* the two discoidal cells are nearly equal in length.

Distribution: INDIA: Kerala.

***Tricentrus speciosus* sp. nov. (Figs. 20–24)**

Female: General colour brown with black shades. Head black, vertical, vertex about two and a half times wider than long, punctate with long adpressed golden hairs, upper margin strongly arcuate and sinuate. lower margin obliquely curved into frontoclypeus; eyes subglobose, brown; ocelli black, nearer to eyes than to each other and situated a little above the centro-ocular line; frontoclypeus extending to half of its length below the lower margin of vertex tip broadly rounded; frontoclypeal lobes

distinct, partially fused. Pronotum brown finely punctate, with long suberect golden pilosity, median carina percurrent through metopidium; metopidium slightly obumbrant and vertical, two and a half times as wide as high, supraocular callosities divided, black; humeral angles prominent, their tips subacute; suprahumeral horns robust very broad-based, basal half brown, rest black, longer than the distance between their bases, tips acute, viewed from lateral aspects directed obliquely outward and forward with the apices curved backwards, lateral carina strong,



Figs. 20–24 *Tricentrus speciosus* sp. nov. 20. Lateral view of female 21. Dorsal view of female pronotum and scutellum 22. Frontal view of male 23. Lateral view of male 24. Frontal view of female

Key to Text-Figures

A1—First Anal Vein; A2—Second Anal Vein; A3—Third Anal Vein; Ap1—First Apical Cell; Ap2—Second Apical Cell; Ap3—Third Apical Cell; Ap4—Fourth Apical Cell; Ap5—Fifth Apical Cell; Apl—Apical limbus; IDC—First Discoidal Cell; 2DC—Second Discoidal Cell

viewed from above moderately broad, with apices obliquely subacute, viewed from front extending outward and moderately upward; posterior process robust, straight, emerging behind the disc, contiguous with scutellum and tegminal inner margin, basal two-thirds dark brown, tip black, acuminate, reaching well beyond claval suture, as backward as the basal half of 5th apical cell of tegmina, strongly tricarinate. Tegmina bronzy, three times as long as wide, basal one-fourth coriaceous black, veins dark brown, tip acutely rounded, apical limbus moderately broad, 1st apical cell about six times as long as its greatest width, 1st discoidal cell not petiolate, nearly as long as the 2nd. Lateral areas of thorax white tomentose. Legs with femora black, tibiae and tarsi dark brown. Abdomen dark brown, ovipositor jet black.

Measurements: Length from frontal margin to tips of tegmina 5.56 mm, to tip of posterior process 3.94 mm; width across tips of suprahumeral horns 3.21 mm, at humeral angles 2.24 mm, at eyes 2.18 mm.

Male: Differing from female in being smaller and darker; suprahumeral horns shorter; tip of posterior process slightly inclined upward above claval suture.

Measurements: Length from frontal margin to tips of tegmina 4.59 mm, to tip of posterior process 3.01 mm; width across tips of suprahumeral horns 2.56 mm, at humeral angles 2.18 mm, at eyes 2.0 mm.

Material examined: Holotype female and allotype male collected from Peparai, Sabarigiri, Kerala; altitude 420 metres; collected by G. Thirumalai; 11.v.1981.

Remarks: *T. speciosus* is closely related to *T. syrandrikan* Thirumalai and Ananthasubramanian in the general size, and *T. fairmarei* Stal (1870) in the general coloration, but differs from both in the disposition of the suprahumeral horns which extend outward and moderately straight, the longer posterior pronotal process in the female and in the marked sexual dimorphism.

Distribution: INDIA: Kerala.

All type materials are deposited in Zoological Survey of India, Southern Regional Station, Madras. They will be transferred, in due course, to National Collections of Zoological Survey of India, Calcutta.

KEY TO THE TRIBES OF SOUTHERN INDIAN CENTROTINAE

1. Hindwings with 4 apical cells 2
- Hindwings with 3 apical cells 3
2. Scutellum well developed and fully exposed; suprahumeral horns present *Leptocentrini* Dist.
- Scutellum weakly developed in the middle and exposed only at sides and basal angles; suprahumeral horns absent *Aleptocentrini* new Tribes
3. Scutellum moderately developed and clearly exposed; suprahumeral horns usually present (reduced or absent in some dimorphic or polymorphic species) 4
- Scutellum aborted in the middle and exposed only at basal angles; suprahumeral horns absent 5
4. Hindtrochanters armed with spines *Tricentrini* Ahmad & Yasmeen
- Hindtrochanters unarmed *Centrotini* Dist.
5. Pronotum tuberculous; mesonotum armed at apex with two tooth-like prolongations; posterior process concavely depressed at base and laminately concavely raised at apex; veins to the apical areas of tegmina strongly curved *Coccosterphini* Dist

- Pronotum not tuberculous; mesonotum unarmed; posterior process straight; veins to the apical areas of tegmina not strongly curved.....Gargarini Dist.

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NEW ASPECTS IN THE BIOLOGY OF SUGARCANE TOP BORER, *SCIRPOPHAGA (NIVELLA F.) EXCERPTALIS* WLK.

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There are four larval instars each in the second and third broods of top borer in Haryana as observed from the size of their head capsules. The first instar larvae enter the midribs mainly through the lower epidermis because they prefer the most tender visible midrib of minus 1 leaf for their entry where only the lower epidermis is available. They tunnel out of the midrib only through the upper epidermis of the midrib probably due to their tendency to move into the central core. Till the larvae moult to fourth instar they remain above the growing point of sugarcane. Many larvae of first and/or second instars and rarely second and third instars are found in a spindle. The reason for the ultimate survival of only one larvae in a spindle is its ability to succeed in the competition to reach near the growing point to get the continuous supply of the specific region of feeding. These findings are significant in the light of understanding the mechanism of resistance in sugarcane varieties to top borer attack.

(Key words: sugarcane top borer, biology)

INTRODUCTION

The life history of top borer, *Scirpophaga (nivella F.) excerptalis* Wlk. was first worked out as early as 1906 by Lefroy and subsequently by other workers (ISAAC & MISHRA, 1933; HALBE, 1950; BEGAL & PATEL, 1953; HUQUE & AGARWALLA, 1955; SRIVASTAVA & SINGH, 1956; GUPTA, 1959; PATEL, 1963; KALRA & SIDHU, 1965) in various parts of India. But aspects such as the reason for the entry of the neonate larvae into the midrib mainly through the hard lower epidermis (RAO, 1947; VERMA & MATHUR, 1950; HUQUE & AGARWALA, 1955; PATEL, 1963; KALRA & SIDHU, 1965) in spite of upper epidermis being soft, number of larval instars, the actual instar that tunnelled down to the growing point of the stem causing dead hearts and the reason for the existence of only one larva per spindle remained to be

studied. To understand the mechanism of resistance to this borer, these factors needed to be studied as also felt by AVASTHY (1969). Hence the present study was taken up.

MATERIALS AND METHODS

The study was conducted at the Regional Centre of Sugarcane Breeding Institute, Karnal, in the variety Co 740.

In the field, the plot size was 250 rows of 3 m length. Initially all the plants showing mid rib tunnels in the second and third broods were removed before artificially infesting the plants with egg masses collected during the second and third broods of the pest and maintained in the laboratory at 25–30°C, the temperature optimum for their hatching. For each brood, 300 egg masses were pinned on the whorl of the plants at the rate of two egg masses per metre row and observed daily for fresh mid-rib tunnelling. Only those plants that showed midrib tunnels on the same day were marked and considered for the study so

that the neonate larvae will be of the same age group as far as possible. Then, all the pinned egg masses and those freshly laid by naturally occurring moths were removed from the experimental plots to prevent the entry of late hatching larvae into these plants under study.

Based on the actual number of plants showing midrib tunnelling by the neonate larvae, 15 randomly selected shoots showing infestation by the second brood larvae were cut on alternate days. Similarly, 20 canes were selected at random daily, for observations during the 3rd brood of the pest. A total of 15 observations during the second brood and 30 during the third brood were made for the larval population in the plant, their position and distance from the growing point, the reason for the existence of only one larva per spindle, the width of the head capsule of the larvae and the region where the exit hole was formed prior to pupation. The size of the head capsule of the first instar larvae was measured from those obtained from the egg masses maintained in the laboratory. In order to find out the reason for the entry of neonate larvae into the midrib mainly through the lower epidermis and to confirm the reason for the existence of only one larva per spindle, a study was conducted in a pot culture experiment and were artificially infested with neonate larvae.

As there was a small variation in the width of the head capsule within each instar, weighted means were calculated to assess the same. Chi-square test of goodness of fit was applied to confirm the number of instars and to test whether the observed variation in the width of the head capsule between contiguous instars was as per Dyar's rule (Imms, 1957).

RESULTS AND DISCUSSIONS

In the potted plants, the inoculated neonate larvae wandered for some time and some tried to disperse by suspending themselves by spinning silken threads. Many larvae moved into the central whorl towards the growing point. But their further downward movement was arrested by the tight clasping of the dewlap of the leaf number +1 to -1 as per Kuijper's system (VAN DILLEWIJN,

1952) of numbering of leaves. The larvae preferred the most tender visible midrib mostly the -1 leaf which [is rolled with only the lower epidermis being exposed. Some larvae also bored into this leaf other than through the midrib and entered the inner midribs. In such inner midribs, the larvae came in contact mostly with lower epidermis because of the nature of arrangement of leaves and sometimes with the upper epidermis also and entered into the midribs depending on the epidermal surface the larvae came in contact with. Sometimes the larvae entered into the midribs of the half opened zero leaf also where both the surfaces of epidermis were exposed. Here again the larvae entered the midrib through the lower epidermis only. Probably it had a better grip in the striated lower epidermis to bite through than the smooth upper epidermis and due to its instinct to bore towards the central core of the spindle. RAO (1947) stated that the larvae bored through the lower epidermis of the midrib because the eggs are laid on the under surface of the leaves. This, however, cannot be a reason, for, the eggs are laid on second to fifth leaf (LEE & PAO, 1962) and the incubation period is 6-15 days (GUPTA, 1959). By the time the eclosion occurred the egg mass bearing leaves would have been pushed down due to plant growth to a lower level and the larvae preferred only the tender midribs of -1 or zero leaf for entry. Moreover, an egg mass contained 10 to 80 eggs (HUQUE & AGARWALLA, 1955) and after eclosion the larvae migrated (GUPTA, 1959) to other plants, where again they entered only through the lower epidermis.

They tunnelled in the same midrib for 24-48 hours and came out always

through the upper epidermis, probably because of their instinct to move interior to central core of the spindle. In the field samples also, as many as four first instar larvae were found to tunnel the midribs of a plant as observed by HUQUE & AGARWALLA (1955) and GUPTA (1959). Sometimes more than one larvae bored into the same midrib forming parallel tunnels.

In a spindle, two or sometimes three larvae of first or second or first and second instars were observed. Rarely second and third instars were also observed. ISAAC (1939) stated that once a larvae entered the growing point no other larva tried to enter the same plant. He might have stated this probably because he found only one larva to exist in a spindle. The position of these larvae were in the inner midribs of unfurled leaves parallel to the central core and/or in the central core at various distances from the growing point. Though many larvae were in a spindle, only one survived ultimately. This is because, at each stadium, the larvae fed only in the innermost core of the spindle, which almost corresponds to the width of their body. This specific region of food becomes continuously available only to that first larva from the growing point as the growing point keeps elongating with growth. So if more than one larva is in the central core, only the lowermost one survives. If there are also larvae in the inner midribs that are parallel to the central core of the spindle, there is competition among these larvae with the lowermost one in the central core. The competition is for being the lowermost larva in the central core to get continuous supply of food. The one which succeeded in this competition alone survived.

The remaining larvae perished of starvation. No cannibalism was observed in the larval habit. They cannot migrate to adjacent plants as they are already in the late second instars and their prolegs became atrophied (GUPTA, 1959).

There were four larval instars in the second and third broods as observed from the width of their head capsule (Table 1). The observed variation in the width of the head capsule between

TABLE 1. Mean width of head capsule of II and III broods of top borer

Instars	Width of head capsule (mm)	
	II Brood	III Brood
I	0.3378	0.3430
II	0.4982	0.4970
III	0.8725	0.8296
IV	1.3547	1.3108
X ² value	0.06441	0.05005

contiguous instars was according to Dyar's rule (IMMS, 1957) with a ratio of 1:1.4. However, the period of each stadium could not be assessed precisely because of destructive sampling.

Till the larvae attained the fourth instar they remained above the growing point. As a rule, only the fourth instar larvae cut across the growing point causing the dead hearts. Out of the fourth instar larvae recovered in the second and third broods, 26.2 and 26.4 per cent respectively were above the growing point. GUPTA (1959) found that young larvae fed in the central core for sometime till they were able to cut the top tender internodes.

Usually the larvae formed the exit hole for moth emergence subsequently in the nodes of No. +4 to +6 of Kuijper system of numbering of nodes (VAN DILLEWIJN, 1952). The bore holes of 89.7 per cent were formed in the nodes out of which 87.7 per cent were formed through the buds.

The leaf forming the dead heart was the one immediately surrounding the feeding region. In this leaf, the feeding extended from the tender inner half to the midrib longitudinally and thus was never severed off transversely. That is why the dead heart is atrophied and cannot be pulled out easily.

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BRIEF COMMUNICATION

ANASTATOIDEA SP. (HYMENOPTERA : EUPELMIDAE) A NEW
PUPAL ENDOPARASITOID OF THE LAC
PREDATOR, EUBLEMMA AMABILIS MOORE
(LEPIDOPTERA : NOCTUIDAE)

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(Received 21 September 1984)

Anastatoidea sp. (Hymenoptera: Eupelmidae) has been recorded for the first time as pupal endoparasitoid of the most serious lac predator, *Eublemma amabilis* Moore, from three lac crops from Bihar and Orissa. The role of allied species has also been discussed.

(Key words: *Anastatoidea* sp., pupal endoparasitoid, *Eublemma amabilis*)

Eublemma amabilis Moore is a serious predator of the lac insect, causing about 30 per cent damage to the lac crops (MALHOTRA & KATIYAR, 1975). Although it has two larval ectoparasitoids of regular occurrence, record of an endoparasitoid has not so far been made, which may perhaps be rare, due to the cryptic life style of the caterpillars which prepare tough galleries and domes for their concealment.

Of the various species of the genus, *Anastatoidea*, records of *Anastatoidea indica* has been made from the lac caged from the host plant, namely, *Butea monosperma* (Lam.) Taub., at this Institute, although its exact role could not be known (VARSHNEY, 1976); of *A. brachartoniae* Gahan as a primary larval/pupal parasitoid of coconut pests, namely

Artona (*Brachartona*) *catoxantha* Hampson (GAHAN, 1927) and *Nephantis serinopa* Meyrick (JOY & JOSEPH, 1976) as well as a secondary pupal parasitoid of *Degeeria albiceps* Macquart, *Ptychomyia remota* Aldrich, *Apanteles* sp., *Apanteles artoniae*, *Goryphus* sp. & *Ptychomyia* sp. (GAHAN, LOC CIT; FERRIERE, 1940); whereas that of *A.* sp. as a larval parasitoid of *Caloptilia* sp. a borer of *Stylsosanthes* spp. (CHACON & CALDERON, 1979).

From the above available evidence it appears that the role of the species of the genus *Anastatoidea* have not been clearly established since these have been reported mainly as larval/pupal primary parasitoids whereas *A. brachartoniae* is known to be a primary parasitoid as well as a secondary parasitoid.

Although the present authors recorded the Parasitoid *A.* sp. from various localities, such as the Institute plantation, Barguttu (Ranchi) and Jaipatna (Orissa) from broodlac caged from jethwi¹ aghani² and baisakhi³ lac crops from time to time, its actual role, could only

1. Lac crop on *kusmi* lac hosts; crop inoculated in Jan./Feb. and matures in June/July.
2. Lac crop on *kusmi* lac hosts; crop inoculated in June/July and matures in Jan./Feb.
3. Lac crop on *rangeeni* lac hosts; crop inoculated in Oct./Nov. and matures in June/July.

be clearly established when it emerged from two field collected pupae of the lac predator *Eublemma amabilis* in the laboratory during the year 1981. A total number of 60 parasitoids have been collected from the above crops, of which 18 were males.

Since the parasitoid appears to be rare and of localized occurrence, a thorough search for building up a nucleus culture for artificial rearing in the laboratory is considered necessary so that its potentialities as a biotic agent for the control of this very serious lac predator could be assessed.

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BRIEF COMMUNICATION

RELATIVE TOXICITY OF SOME INSECTICIDES TO THE SECOND INSTAR LARVAE OF *LYMANTRIA OBFUSCATA* WALKER

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Against the second instar larvae of Indian gypsy moth *Lymantria obfuscata* Walker, mevinphos was found to give the highest toxicity and proved 8.11 times more toxic than carbaryl.

(Key words:—Insecticide toxicity, *Lymantria obfuscata*)

INTRODUCTION

Indian gypsy moth, *Lymantria obfuscata* Walker is considered a major defoliation pest of fruits and forest plantation in Jammu and Kashmir State. For the last two decades it has assumed menacing proportions and is now a major insect threat to the fruit industry (MALIK *et al.* 1972; SHIEKH, 1976; DAR *et al.*, 1977). DAR *et al.* (1977) tested endosulfan, dichlorvos, fenitrothion, BHC and sumithion for their efficacy against first and second instar larvae of *Lymantria obfuscata*. In the present investigations the toxicity of some new insecticides on the second instar larvae of *L. obfuscata* has been evaluated.

MATERIALS AND METHODS

Second instar larvae of *L. obfuscata* were tested in three replicates, each containing 20 larvae in 200 mm dia petri dishes lined with filter paper. Small bunches of willow leaves were fully dipped in five concentrations of

each insecticide and allowed to dry. The cut petioles of treated leaves were wrapped in wet cotton and kept in petri dishes. Twenty second instar larvae of similar age and size were released in each petri dish. For the assessment of toxicity mortality counts were taken 48 hours after the treatment. The moribund larvae were considered as dead. The corrected percentage mortality of larvae in the treatment was calculated according to ABBOT (1925). The data were subjected to probit analysis (BUSVINE, 1971).

All the technical grades of the insecticides (Table 1) made into emulsions using benzene as solvent and Triton X-100 as emulsifier. While formulating different concentrations of each insecticide allowance was made for actual active ingredient present in the technical grade.

RESULTS AND DISCUSSION

Out of eighteen insecticides tested 12 insecticides were more effective than carbaryl. Highest toxicity was recorded in mevinphos which proved 8.11 times more toxic than carbaryl. The order of toxicity of insecticides was, mevinphos, parathion, monocrotophos, phosphamidon, endosulfan, dichlorvos, methyl parathion, methyl demeton, fenthion, thiometon, fenitrothion and dimethoate.

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TABLE 1. Relative toxicity of different insecticides against larvae of *Lymantria obfuscata*.

Insecticide	Heterogeneity	Regression equation	LD ₅₀	Fiducial limits	Relative toxicity	Order of toxicity
Methyl Parathion	$\chi^2(3) = 10.281$	$Y = 1.609X + 1.0778$	0.02738	0.02771 0.02706	1.46	7
Monocrotophos	$\chi^2(3) = 2.647$	$Y = 1.2573X + 2.5372$	0.00909	0.009462 0.008740	4.42	3
Endosulfan	$\chi^2(3) = 10.730$	$Y = 1.4072X + 1.7691$	0.01976	0.02015 0.01936	2.03	5
Malathion	$\chi^2(3) = 1.998$	$Y = 1.0831X + 1.7631$	0.9740	0.1511 0.06279	0.41	15
Methyl demeton	$\chi^2(3) = 9.216$	$Y = 1.5146X + 1.3045$	0.02754	0.02789 0.02719	1.45	8
Parathion	$\chi^2(3) = 6.842$	$Y = 1.4605X + 2.5672$	0.00665	0.006285 0.003415	6.04	2
Dimethoate	$\chi^2(3) = 6.456$	$Y = 1.3078X + 1.4762$	0.04950	0.05030 0.04871	0.81	14
Carbaryl	$\chi^2(3) = 6.668$	$Y = 1.4428X + 1.2430$	0.4018	0.05144 0.03138	1.00	13
Fenthion	$\chi^2(3) = 8.456$	$Y = 1.7910X + 0.5761$	0.02952	0.02980 0.02924	1.36	9
Dichlorvos	$\chi^2(3) = 7.013$	$Y = 1.3865X + 1.7924$	0.02058	0.02701 0.02016	1.95	6
Lindane	$\chi^2(3) = 1.148$	$Y = 1.8186X + 0.4954$	0.1054	0.1076 0.1027	0.38	16
Carbophenothion	$\chi^2(3) = 3.494$	$Y = 1.3249X + 0.8975$	0.1248	0.19360 0.08052	0.32	18
Fenitrothion	$\chi^2(3) = 7.500$	$Y = 1.1674X + 20.0558$	0.03328	0.03470 0.03264	1.20	11

(continued)

TABLE-1. Continued

Insecticide	Heterogeneity	Regression equation	LD ₅₀	Fiducial limits	Relative toxicity	Order of toxicity
Formothion	$\chi^2 (3) = 3.416$	$Y = 0.5705X + 4.1639$	0.1235	0.3073 0.04955	0.32	17
Mevinphos	$\chi^2 (3) = 5.992$	$Y = 1.3050X + 2.7869$	0.00495	0.0068 0.0035	8.11	1
Dimethoate	$\chi^2 (3) = 10.706$	$Y = 10.7765X + 2.9985$	0.03497	0.03671 0.03332	1.14	12
Phosphamidon	$\chi^2 (3) = 8.810$	$Y = 1.5431X + 1.7173$	0.01341	0.01370 0.01312	2.99	4
Thiometon	$\chi^2 (3) = 7.002$	$Y = 1.5921X + 1.0495$	0.03029	0.03066 0.02993	1.32	10

Note:—1. Y = Probit kill, X = log concentration. 2. Methyl parathion, endosulfan, methyl demeton, demethoate, fenitrothion and phosphamidon were significantly heterogeneous at $P=0.05$

Dimethoate, malathion, lindane, formothion and carbophenothion proved less toxic than carbaryl.

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REPORTS AND NEW RECORDS

NEW RECORD OF A DESERTICOLOUS MANTID FAMILY (MANTODEA : EREMIAPHILIDAE) FROM INDIA

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Sand-dwelling praying mantid *Eremiophila irridipennis* Lefv. of Order Mantodea represents a first record of the family Eremiophilidae from India. A detailed description with two plates are given.

(Key words: mantid, new record).

The family Eremiophilidae of sand coloured deserticolous mantids, was so far known only from deserts of South-West Asia and the present species was formerly recorded from Egypt. Kirby (1904) first designated the species as distinct from *E. typhon* Lefv. 1835.

A male and a female specimen was received while going through the collection from Gujarat sent to Zoological Survey of India for identification.

Description: Body small (Figs. 1 and 2) greyish brown, a blackish tinge on ventral surface of female. Tarsa 5-jointed, walking legs slender and long.

Frontal sclerite transverse, upper margin rounded and lower margin wider and briefly concave. Superior margin of the head is round and without any deep furrow, excepting two

indistinct ones on either side of the eye. Eyes with almost rounded margins and they are slightly pronounced.

Pronotum square, lateral margins are slightly divergent anteriorly and the surface is with bosselles. There are two prominent rounded bosselles at the mid-posterior margin. Carina absent in male, feeble in metazona in female. The brown spots are present throughout the shield.

Fore legs are stout; the coxae with few spinules along inner edges. Internally a brownish patch is present, formed by dots in male, by an entire patch in female. Femora internally with a brownish band; externally it is broadly brownish in male. In female the femora is blackish. There are 4 discoidal and 4 outer spines. Internal spines are black, small and numerous. Tibiae with 5 external spines; the distal one is the longest; internal spines are many, gradually longer towards the apex. Upper margin of femora slightly arched. Its outer surface with dense brownish spots.

The middle and posterior legs are much longer and with apical spines. They are narrow and the femora with few spinules along ventral edges. Very faint two or three brownish bands are indistinctly present.

The elytra are short in both the sexes; oval to round and their apical half of discoidal area is blackish; the rest part is brownish and opaque. Venation is reticular with apparently ridged longitudinal veins. It extends to the 2nd abdominal segment.

Abdomen is much wider (9.5 mm) in ♀ in relation to its length (7.5 mm). The last sternite is produced into a

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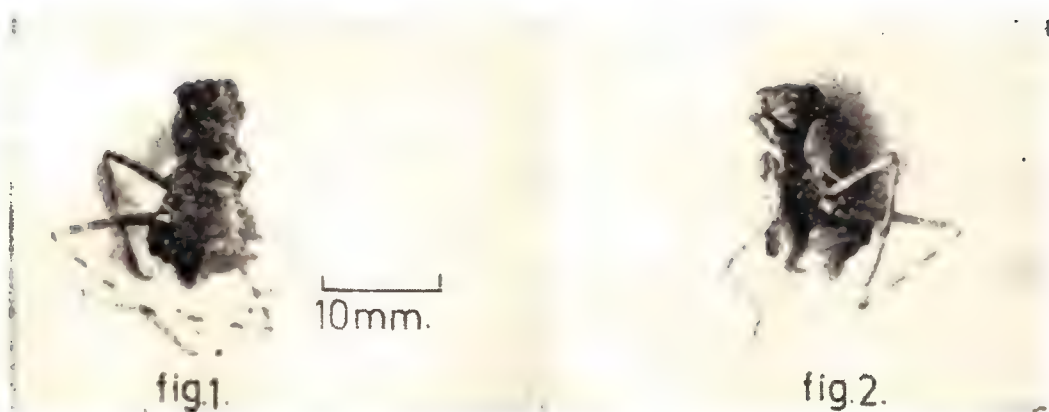


Fig. 1. *Eremiaphila irridipennis*—Dorsal view showing pronotum, elytra and flattened abdominal tergites; Fig. 2. *Eremiaphila irridipennis*—Ventral view showing spiniform projection of last abdominal sternite.

pair of spiniform projection in female. The supra-anal plate in male is transverse. Cerci 4-5 segmented.

The measurement of different body parts are given in Table 1.

TABLE 1.

Parameters	Male (mm)	Female (mm)
Body length	17.0	17.2
Elytra (Length/Width)	4.5/5.0	—
Fore coxa	3.3	3.5
Fore Femur	4.3	4.7
Fore Tibia	2.6	2.7
Middle Coxa	2.8	—
Middle Femur	7.0	—
Middle Tibia	5.5	—
Hind Coxa	2.2	—
Hind Femur	9.0	—
Hind Tibia	8.0	—
Pronotum (Length/Width)	3.8/4.40	3.9/4.5

This species is close to *E. typhon* Lefv. 1835 but differs by the presence

of 5 external spines on the fore tibiae and also by the structure of the elytra and the band pattern.

Distribution: Africa, Egypt, India; Gujarat, Rajkot ♂ & ♀; Coll. V. C. Soni, dated 30. ix. 1981, Z. S. I. Eng. Regd. No. 158/81 Z. S. I. Regd. No. of ♂ is 10047/H₅, of ♀ 10048/H₅.

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OCCURRENCE OF *PERICYMA* *CRUEGERI* BUTTLER AS A DE- FOLIATOR OF *DELONIX* *REGIA* RAF.

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The semilooper caterpillars of *Pericyma cruegeri* Buttler has been recorded for the first time as defoliators of *Delonix regia* Raf.

(Key words: *Pericyma cruegeri*, defoliator, *Delonix regia*).

The semi-looper caterpillars of *Pericyma cruegeri* Buttler (Ophiderinae: Noctuidae) were recorded for the first time causing severe defoliation of the shade tree, *Delonix regia* Raf. (Caesalpinia: Leguminosae), at Medziphema and Dimapur (Kohima District, Nagaland) during 1982-1983, although this species and its relatives are known to feed on legume plants (J. D. HOLLOWAY, personal communication). NAIR (1975) reported *P. glaucinans* (Guen) feeding on *Indigo*, and defoliating *Dhanicha* and *Agathi* plants in Tamil Nadu. The

caterpillars appeared in April, 1982 and reached peak of abundance in October—November, causing complete defoliation. The infestation was so severe that the faecal pellets of the larvae were seen as a distinct layer on the adjacent roads. The larvae however, disappeared, most probably due to hibernation, from the end of November 1982 to March, 1983 (Winter season reappearing again in April, 1983).

The caterpillars were recorded feeding on the leaflets mostly being attached to the rachis of the pinnately compound leaf. They eat from the edges of the leaflets sometimes consuming them entirely and sometimes leaving them half eaten. The fully grown larvae pupated into cocoons in folded green leaflets and rachis of the bipinnate leaves. The cocoons were, in the beginning, whitish in colour enclosed by green leaflets which later turned to dark brown.

Acknowledgements: J. D. HOLLOWAY, Esq. (C.I. E., London) identified the insect. M.A.A. and S.P.T. are grateful to ICAR (New Delhi) for the award of S. R. F. under the scheme No. 1-19/80-pp sanctioned to Dr. M. V. R.

REFERENCE

- NAIR, M. R. G. K. (1975) *Insects and Mites of Crops in India*. Indian Council of Agricultural Research, New Delhi.

ANNOUNCEMENTS

The Department of Science & Technology has initiated a scheme for the Promotion of Scientific Interest in Youth. Under this programme, various activities like Research Projects, Socio-economic projects, Seminars and Symposia etc. basically aimed at young scientists are supported financially by this Department. The Science and Engineering Research Council constituted by this Department has further recommended that a new scheme should be developed to promote excellence in research through providing financial support to motivated young scientists. Information on these two schemes for the promotion of Scientific Interest in Youth is given below.

DEPARTMENT OF SCIENCE & TECHNOLOGY, STP DIVISION

Title: Scheme for Promotion of Scientific Interest in Youth (PSIY)

Objectives:

1. To promote and sustain scientific interest in youth during their creative period of career.
2. To provide opportunities to young scientists for pursuing exciting and innovative research ideas.
3. To provide opportunities for interaction and exchange of ideas with the scientific community etc.

Who can apply:

- The scheme covers young scientists in the age group of 18-35 years.
- Young scientists who have adequate background in any field of Science and Technology and show inclination to undertake an activity for the fulfilment of the objective of the scheme.

Activities:

- Creativity Encouragement Projects of about two year duration requiring seed-money upto Rs 1.0 lakh;
- Socio-economic Development projects;
- Seminars/Symposia;
- Awards through INSA and ISCA;
- Contact Programme with eminent scientists;
- International Travel Assistance.

When to apply:

- Any time on the prescribed format obtainable from DST.

P. T. O.

**MINISTRY OF SCIENCE & TECHNOLOGY
(DEPARTMENT OF SCIENCE & TECHNOLOGY)**

Title: Science and Engineering Research Council Young Scientists Scheme. (SERCYS)

I. Objectives

1. To provide quick research support to young scientists to pursue their bright ideas in newly emerging and frontline areas of research in Science & Engineering;
2. To work for integrated research programmes involving inter-disciplinary fields;
3. To support inter-institutional programme.

II. Who can apply:

- The scheme is open to young scientists below 30 years.
- Researchers/Scientists who have shown promising achievement during their Ph. D. and/or subsequent work are eligible.
- Applications need not be forwarded/routed through any institutions at this stage but once the proposal is approved a certificate of affiliation to an institute is necessary.

III. Duration and financial limit:

1. Projects under this scheme would be sanctioned for a period of 2 years.
2. The total cost of the project for this period should not exceed Rs 2.5 lakhs.

IV. When to apply:

The project proposal in 5 (five) copies should reach Department of Science & Technology by 31st January and 31st July of each calendar year, on the prescribed form.

Contact address

Science & Technology Promotion Division,
Young Scientists scheme,
Department of Science & Technology,
Technology Bhavan,
New Delhi-110 016.

Symposium on Physiological Basis of Health

A national symposium on Physiological Basis of Health is being organised at Madurai Kamaraj University from 10-12 February 1986. Further information may be had from Prof. Dr. T. J. Pandian, Organising Secretary, Symposium on Biological Basis of Health, School of Biological Sciences, Madurai Kamaraj University, Madurai 625 021.

ENTOMON is covered in the following abstracting/indexing journals : *Chemical abstracts* (Chemical Abstracts Service, The Ohio State University, Columbus, Ohio 43210, U. S. A.), *Review of Applied Entomology* (Commonwealth Institute of Entomology, 56 Queen's Gate, London SW9 5JR, England), *Science Citation Index* and *Current Contents Agriculture, Biology & Environmental Sciences* (Institute of Scientific Information, 3501 Market Street, Philadelphia, Pa. 19103, U.S.A.), *Biological Abstracts* (Biosciences Information service, 2100 Arch street, Philadelphia, Pa. 19103, U. S. A.), *Entomology Abstracts* and other relevant *Abstracts* (Information Retrieval Limited, 1 Falconberg Court, London W1V 5FG, England), *Referativnyi Zhurnal* (The Institute of Scientific Information, Academy of Science of the U. S. S. R., Baltijskaya ul., 14, Moscow A—219, U. S. S. R.), *Current Advance in Biological Sciences*, 132 New Walk, Leicester LE1 7QQ, England